BLM

CAVE AND KARST

RESOURCES MANAGEMENT HANDBOOK

BLM Management Handbook H-8380-1

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Chapter 1: Introduction

This handbook is formatted to match the syllabus, lesson plans, and presentations of the BLM National Training Center course Cave and Karst Resources Management. Much of the reference and support material for these chapters is contained in the Appendix.

I. HANDBOOK SUMMARY

Chapter 1: Introduction

The introduction describes the purpose of the handbook and the need for cave and karst resources management. It identifies the different types of caves and where they may be found. It covers the different laws and regulations that are associated with the management of caves and karst resources and how they may be applied.

Chapter 2: Significant Cave Identification and Designation

This chapter covers the implementation of 43 CFR Part 37, the definition of a cave, the significance criteria, the significant cave inventory and designation process (both internal and external), and reporting significant caves in the Recreation Management Information System (RMIS)

Chapter 3: Resource Planning

This chapter discusses: 1) Why land use planning is needed, 2) The required parts to include in resource management plans (management, marketing, monitoring, and administration), 3) RMP cave management planning process, 4) cave activity plans, and 5) linking plans to the budget process.

Chapter 4: Integrating Surface and Subsurface Resources

This chapter covers how to find caves and looks at the external and internal threats to caves and karst systems.

Chapter 5: Implementation Strategies

This chapter is perhaps the most detailed and comprehensive for implementing on-the-ground actions and protection methods. It covers; 1) Protection and Conservation strategies for cave and karst resources that involve administrative, regulatory, physical means, education, and outreach methods, 2) cave permits and permitting systems, 3) monitoring systems, 4) restoration methods, 5) cave surveys and mapping, 6) research proposals, 7) cave safety standards, 8) partnerships and agreements, 9) levels of liability and how to minimize risk, 10) geocaching activities in caves, 11) Outfitter/Guides and Commercial Use, and 12) Best Management Practices and Strategies relating to other uses on cave and karst lands such as; linear rights of way, oil and gas drilling and production, grazing, and logging.

II. PURPOSE AND NEED FOR CAVE/KARST RESOURCES MANAGEMENT

The management of caves and karst lands is a responsibility of the Bureau of land Management and is required by a variety of laws and regulations. The management of karst lands requires a wide diversity of sciences and programs including geology, hydrology, biology, mineralogy, archaeology, paleontology, and recreation. These sciences and others make up the science of Speleology (the study of caves). A basic understanding of these components and how they interrelate is required to successfully manage such complex systems as caves and karst lands. Not all caves are formed in karst lands. Some caves are formed in lava flows or as a result of non-karst erosion, such as talus caves, sea caves, and aeolian caves.

Caves and karst lands are not well understood and their management requirements are often not apparent. The management of the subsurface is largely dependent on the appropriate management of the surface. The two are inextricably connected. In karst lands what happens on the surface affects the subsurface and vice versa.

BLM employees involved in this program may include; cave specialists, outdoor recreation planners, wildlife biologists, archeologists, hydrologists, geologists, range conservationists, and others who have an interest in speleology and the management of caves and karst landscapes. Each of the eleven western BLM states has a state cave program lead that coordinates the activities within the state.

Purpose

The procedures and guidelines contained in this handbook provide detailed on-the-ground guidance needed to implement the BLM 8380 Manual, Cave and Karst Resources Management. The Manual sets overall policy and direction, the Handbook provides users with a reference for resource identification, significance nomination and designation, inventory and monitoring, planning, outreach, and other aspects of the cave and karst resources management program. It also gives several examples of documents needed to implement management decisions.

Objectives

The objective of the Cave and Karst Resources Management program is to establish maxim consistency and continuity in the management of caves and karst resources, to identify those resources, and manage them to protect their inherent values in accordance with existing laws and regulations.

Authority

The Federal Cave Resources Protection Act (FCRPA) of 1988, 16 U.S.C. §§ 4301–4310 and the Federal Land Policy and Management Act (FLPMA) grant authority for this program.

Responsibility

The Bureau of Land Management (BLM) National Cave and Karst Resources Management Program is responsible for the development and dissemination of policies, guidelines, training, and information relevant to the management and protection of cave and karst resources.

References

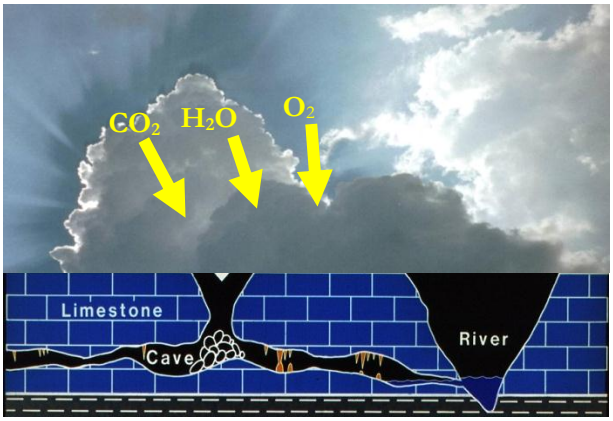
The following federal references apply to the BLM Cave and Karst Resources Management Program:

- The Federal Cave Resources Protection Act (FCRPA) of 1988, 16 U.S.C. §§ 4301–4310,
- 43 CFR Part 37
- LM Manual 8380 (Cave and Karst Resources Management)

III. TYPES OF CAVES

A. Solution Caves

Solution caves are the most common type of cave. They can be found in limestone, dolomite, marble, gypsum, salt, or any other type of soluble rock type. These caves are formed by rock being dissolved along, and adjacent to, joints (fractures), faults, and layers in the rock. The processes involved are both chemical (corrosion) and physical (erosion). There are basically two types of solution cave. One is Epigenic being formed by the action of weak carbonic acids derived from the atmosphere, soils, and oxidation of sulfides in the vados zone. Recharge of this type of system is largely from overlying surface waters traveling downward and is generally climate dependent.



The second type of solution cave is Hypogenic, which are formed by acids generated within the earth from compounds such as methane, hydrogen sulfide, carbon dioxide, and other organic acids. Solutional activity occurs as weak acids flow upward into carbonate zones without a relationship to surface waters, although mixing of surface water may occur. Hypogenic karst may not be evident on the surface in the form of sinkholes, sinking streams, or cave entrances. This type of cavern development accounts for 5 to 10% of all caves.

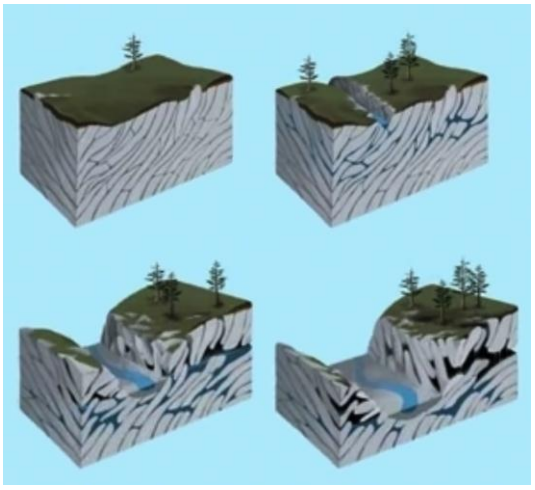
Epigenic solution cave development occurs as follows; Text and graphics are from the "California Underground" website

Step 1 - Rain falling on a limestone terrain reacts with carbon dioxide, produced by the decay of plant material in the soil, forming a weak carbonic acid H2CO3)

Step 2 - The acidic groundwater accumulates at the surface of the water table and begins to dissolve the soluble rock forming flooded passages into the bedrock.

Step 3 - The deepening river valley drains away ground water, lowering the water table and draining the caves. The valley intersects the cave passage, revealing an entrance.

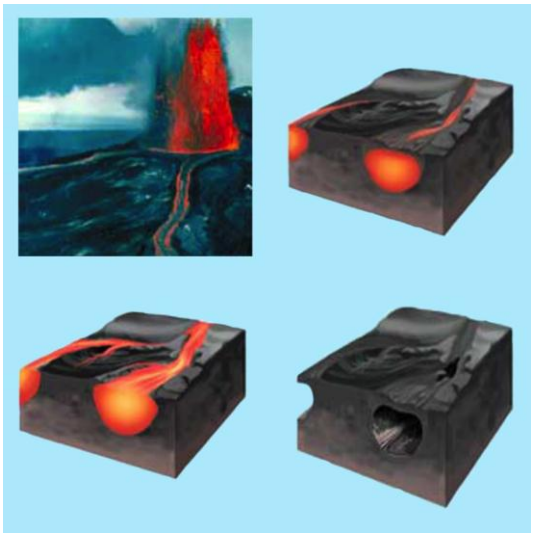
Step 4 - Once the cave is opened to the atmosphere, carbon dioxide can escape from the cave. This allows the groundwater seeping into the cave to release carbon dioxide and redeposit the dissolved limestone it may carry. This forms calcite stalactites and stalagmites.



B. Ice Caves

The term "ice cave" requires some clarification because it has been applied to caves that form both in ice and in rock. Ice caves that form in ice are also called glacier caves. Melt water moving through glaciers can form this type of ice cave. Caves, formed in rock, that contain ice all year round are also referred to as ice caves. They are also called frozen caves. These caves may contain very large crystals of ice that form on the floors, walls, and ceilings of the cave.

C. Lava Tube Caves



As fluid, molten lava flows out of the ground, it works its way downhill. Soon the surface of this lava stream cools and hardens into a crust. Although the outer crust is hard, the lava inside is still molten, and continues to flow downhill. Once the molten lava has passed through, a lava tube, or cave, is all that remains.

Step 1 - Lava erupting from volcanoes flows like a river down the flanks of the volcano.

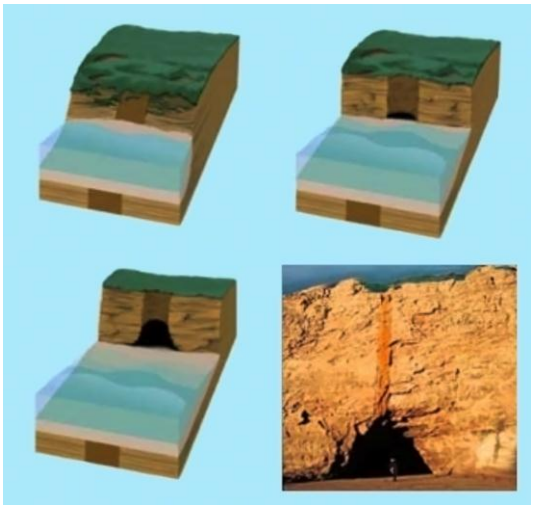
Step 2 - Lava spilling or splattering over the banks of the lava river forms natural levees, further channeling the flow.

Step 3 - If the lava meets a downstream blockage, the lava slows; the surface cools and forms a solid crust.

Step 4 - If the lava breaks through the downstream blockage, the lava will flow again. When the eruption slows, or if the flow is diverted elsewhere, the tube drains and a lava-tube cave is born.

D. Sandstone Caves

Caves formed in sandstone are generally shallow but can sometimes extend for several meters into the rock.



Step 1 - Moisture persists on the shady side of a sandstone rock. Here it dissolves away the substances that glue together the rocks' component sand grains +- Sea caves are formed by the action of waves pounding against rocks that line the shores of oceans and larger lakes. Sea caves are evidence of the enormous power of waves. Sea caves may be further modified and enlarged by wave-carried sand and gravel.

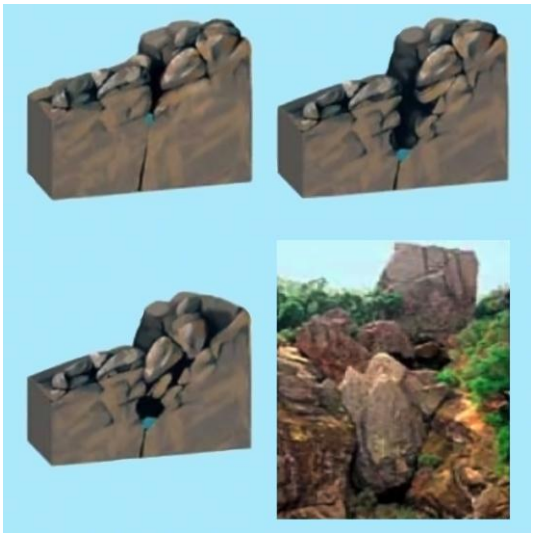
Step 2 - On rocky shorelines, the relentless surf erodes weak points in the cliffs forming sea caves. As the glaciers melted at the end of the ice age, the sea level rose. The eroding surf cut coastal bluffs as the ocean flooded inland.

Step 3 - Some parts of the shoreline rock were softer than surrounding rock. There erosion proceeded faster.

Step 4 - A large cave has formed in the weak portion of the rock.

Step 4 - The bluff will continue to erode inland. Where the cave is today, will in time, be carved away.

E. Talus Caves



Gravity can move large masses of rock that arch over spaces forming caves. These can be landslides of rock slabs or rubble, or the slow creep of gradually sagging clay beds.

Step 1 - A stream winds its way along cracks in a boulder-strewn landscape.

Step 2 - In time the stream cuts a deep slot canyon through the rocks.

Step 3 - Boulders on the canyon rim tumble into the slot canyon, roofing it over.

Step 4 - Additional boulders accumulate further roofing over the cave.

F. Tectonic Caves

Earthquake activity can create fissures in the bedrock called earth cracks, along joints and as a result of faulting. Some of the deepest earth cracks are in Arizona caused by volcanic activity near Flagstaff. As the San Francisco Mountains rose up as volcanoes, the limestone was fractured to depths of over 500 feet.

IV. LAWS

A. Federal Cave Resources Protection Act of 1988 16 U.S.C. §§ 4301–4310

The Federal Cave Resources Protection Act (FCRPA) provides the primary legal basis used to manage and protect caves and their resources on federal lands. The following are key components of the act that are used to guide the overall direction of the program. Details may be found within the Law (appendix 1–1).

Section 2 - Findings, Purpose, and Policy

- Caves are an invaluable and irreplaceable resource on public lands,
- Purposes; Secure, Protect, and Preserve Significant Caves on Federal Lands, and
- Foster cooperation and exchange of information between Government and cave users
- Policy; Manage federal lands to protect and maintain significant caves, to the extent practical

Section 4 - Management Actions

- Identify and designate Significant caves. Protect caves under consideration for significance designation during the period of consideration.
- Protect Significant caves through restrictions
- Enter into agreements with scientific and recreational interest groups
- Ensure caves and their resources are included in all land use planning actions
- Foster communication, cooperation, and exchange of information between land managers, those who utilize caves, and the public.

Section 5 - Confidentiality of Information

- Maintain confidentiality of cave locations
- Information may be made when in compliance with detailed request

Section 6 - Collecting and Removal from Caves

- Permits may be issued for collection of cave resources after review of a detailed written request (see Chapter 5–VI for details)
- Permits may be revoked
- Permits are not Transferable
- Indian Tribes have primary jurisdiction on Tribal lands

Section 7 - Prohibited Acts and Criminal Penalties

- Knowingly destroy, disturb, deface, mar, alter, remove, or harm any significant cave or resource
- Possess, consume, sell, barter or exchange, or offer for sale, barter or exchange, any cave resource
- Counsel, procure, solicit, or employ any other person to violate any provisions of the law
- Punishment shall be imprisonment, fine, or both.

Section 8 - Civil Penalties

- Penalties will be assessed on violators according to violation severity, economic benefit, and history of violations. An opportunity to request a hearing within 30 days will be given
- Maximum fine $10,000
- A petition for judicial review may be filed within 30 days.

Section 9 - Miscellaneous Provisions

- Funds, fees, or fines collected through the FCRPA may be available for improved management, benefit, repair, or restoration of significant caves
- The FCRPA is subject to valid existing rights
- The FCRPA does not cover appropriations of water rights or any jurisdiction of fish or wildlife.

B. Other Laws

1. **Federal Land Policy and Management Act 1976 (43 USC 1701)** - Additional authority to enter into agreements.
2. **National Cave and Karst Research Institute Act of 1998** - Provides a national research group to partner with for speleological research and applied science and management strategies.
3. **Clean Water Act** - Can be used to help protect critical ground water recharge areas that may vital to cave resources.
4. **Wilderness Act 1964** - Provides wilderness protection to all caves and karst lands with wilderness or wilderness study area designation.

5. **Archaeological Resources Protection Act 1979, National Native American Grave Protection and Repatriation Act 1990 (25 USC 3001), Antiquities Act 1906 (16 USC 431)** - These laws protect archaeological or historical resources in caves.

6. **Endangered Species Act 1973** - Can be used to protect cave dwelling species.

7. **Sites Act of 1974** - Can be used to help fund bat friendly cave gates and other cave wildlife related projects.

8. **Fish and Wildlife Conservation Act 16 U.S.C. 1980** - Useful for protecting cave wildlife.

9. **General Mining Law 1872 (30 USC 22–47)** - This is a good law to be familiar with because of its potential effect on cave and karst resources.

10. **Mineral Leasing Act of 1920 (30 USC 181–263)** - Actions under these laws may be withdrawn or closed to entry through planning or congressional actions.

There are several state game and wild life laws that may also be useful.

V. REGULATIONS

A. 43 CFR Part 37 Cave Resources Management

These are Department of the Interior regulations that apply to the BLM, National Park Service, the US Fish and Wild Life Service, and the Bureau of Reclamation. The US Forest Service has regulations that mirror these. This section is intended to provide an abbreviated reference to the Regulations that apply to the BLM. For details please see the complete regulation in Appendix 1–2.

1. **Subpart A: Cave Management** - General

   a) **Purpose** - The purpose of this section is to provide the basis for identifying and managing significant caves on Federal lands by the Secretary of the Interior.

   b) **Policy** - It is the policy of the Secretary that Federal lands be managed in a manner which, to the extent practical, protects and maintains significant caves and cave resources. The type and degree of protection will be determined through the agency resource management planning process with full public participation.

   c) **Authority** - Section 4 of the Federal Cave Resources Protection Act of 1988 (102 Stat. 4546; 16 U.S.C. 4301).

2. **Subpart B: Cave Designation** - Nomination, Evaluation, and Designation of Significant Caves

   a) **Nominations** - Nominations will be accepted from governmental agencies and the public by the agency that manages the land where the cave is located. The evaluation of the nominations for significant caves will be carried out in consultation with individuals and organizations interested in the management and use of cave resources, within the limits imposed by the confidentiality provisions.

   b) **Nomination Evaluation Criteria** - Nominations will be evaluated using the criteria for significant caves. A significant cave on Federal lands shall possess one or more of the following features, characteristics, or values: (1) Biota, (2) Cultural, (3) Geologic/Mineralogic/Paleontologic, (4) Hydrologic, (5) Recreational, (6) Educational or Scientific.

c) **Special Management Areas** - Within special management areas that are designated wholly or in part due to cave resources found therein, all caves within the designated special management area shall be determined to be significant.

d) **Designation and Documentation** - If the authorized officer determines that a cave meets one or more of the criteria the cave will designate the cave as significant. Each Field office will retain appropriate documentation for all significant caves located within its administrative boundaries. At a minimum, documentation shall include a statement of finding signed and dated by the authorized officer, and the information used to make the determination. This documentation will be retained as a permanent record in accordance with the confidentiality provisions.

e) **Decision Final** - Decisions to designate or not designate a cave as significant are made at the sole discretion of the authorized officer and are not subject to further administrative review or appeal.

If a cave is determined to be significant, its entire extent, including passages not mapped or discovered at the time of the determination, is deemed significant. This includes caves that extend from lands managed by any Federal agency into lands managed by one or more other bureaus or agencies of the Department of the Interior, as well as caves initially believed to be separate for which interconnecting passages are discovered after significance is determined.

3. Confidentiality of Cave Location Information

No Department of the Interior employee shall disclose information that could be used to determine the location of any significant cave or cave under consideration for determination, unless the authorized officer determines that disclosure will further the purposes of the Act and will not create a substantial risk to cave resources of harm, theft, or destruction.

Requesting confidential information - The authorized officer may make confidential cave information available to a Federal or State governmental agency, bona fide educational or research institute, or individual or organization assisting the land managing agency with cave management activities. To request confidential cave information such entities shall make a written request to the authorized officer that includes the following:

1) Name, address, and telephone number of the individual responsible for the security of the information received.

2) A legal description of the area for which the information is sought.

3) A statement of the purpose for which the information is sought, and

4) Written assurances that the requesting party will maintain the confidentiality of the information and protect the cave and its resources.

There are numerous other Federal Laws and regulation that can be used to protect cave and karst resources. An annotated listing of these laws can be found in Appendix 1–3. The following CFR citations provide additional rules that may be used in the protection of cave and karst resources.

B. Other Regulations

These are additional regulations that can be used to protect cave and karst resources and can be cited by law enforcement.

1. 43 CFR Part 9229 **Trespass** (Removal of cave minerals)
2. 43 CFR Part 6200 **Protection and Preservation of Natural Values**
3. 43 CFR Part 11 **Natural Resource Damage Assessment**
4. 43 CFR Part 8300 **Recreation Management**
5. 43 CFR Part 8341 **Conditions of Recreation Use**
6. 43 CFR Part 8344 **Recreation Permits**
7. 43 CFR Part 8351.2–1 **Special Recreation Rules**
8. 43 CFR Part 8365 **Rules of Conduct**
9. 43 CFR Part 8365.1–6 **Supplemental Rules**

Chapter 2: Significant Cave Identification, Nomination, and Designation

I. IDENTIFICATION

The "significant cave" provision in the Federal Cave Resources Protection Act was added to the bill late in the legislative process to provide a screening process so that federal agencies would not be required to "manage every little hole in the ground" or to screen out cave-like features containing "...no resources of any interest to anyone or any recognizable natural resource value". It is clearly the intent of the Act that significant caves include all caves that meet any one of the criteria in the regulations. A cave need not be special or different to be listed as significant. The initial procedure for the listing of Significant Caves was laid out in detail in Instruction Memorandum No. 94–125 in February 1994. (Appendix 2–1)

The purpose of designating caves as significant is to identify those caves that contain features or resources needing protection under the Federal Cave Resources Protection Act. In many instances the fact that a cave or karst feature fits the definition of a cave is enough to qualify it as significant. The intent of designating a cave as "significant" is: 1) to verify that the feature is indeed a cave, 2) to form the basis of an inventory for the cave, and 3) to have it entered into BLM records. The Significant Cave Inventory Criteria can be found in 43 CFR Part 37 (Appendix 1–2).

A. Definition

First, a feature must meet the definition of a cave as written in the Federal Cave Resources Protection Act of 1988. A cave is defined as: "any naturally occurring void, cavity, recess, or system of interconnected passages which occurs beneath the surface of the earth or within a cliff or ledge (including any cave resource therein) and which is large enough to permit an individual to enter, whether or not the entrance is naturally formed or manmade. Such term shall include any natural pit, sinkhole, or other feature which is an extension of the entrance."

Second, the cave must be determined to be in Bureau of Land Management jurisdiction for which a precise location is required.

B. Significance Criteria

Third, the cave must meet at least one of the criteria given in 43 CFR Part 37, subpart B, 37.11, (c):

1. **Biota** - The cave provides seasonal or yearlong habitat for organisms or animals, or contains species or subspecies of flora or fauna that are native to caves, or are sensitive to disturbance, or are found on State or Federal sensitive, threatened, or endangered species lists.

2. **Cultural** - The cave contains historic properties or archaeological resources (as described in 36 CFR 60.4 and 43 CFR 7.3) or other features that are included in or eligible for inclusion in the National Register of Historic Places because of their research importance for history or prehistory, historical associations, or other historical or traditional significance.

3. **Geologic/Mineralogic/Paleontologic** - The cave possesses one or more of the following features:

    a) Geologic or mineralogic features that are fragile, or that exhibit interesting formation processes, or that are otherwise useful for study.

    b) Deposits of sediments or features useful for evaluating past events.

    c) Paleontologic resources with potential to contribute useful educational and scientific information.

4. **Hydrologic** - The cave is a part of a hydrologic system or contains water that is important to humans, biota, or development of cave resources.

5. **Recreational** - The cave provides or could provide recreational opportunities or scenic values.

6. **Educational or Scientific** - The cave offers opportunities for educational or scientific use; or, the cave is virtually in a pristine state, lacking evidence of contemporary human disturbance or impact; or, the length, volume, total depth, pit depth, height, or similar measurements are notable.

II. THE SIGNIFICANT CAVE NOMINATION AND DESIGNATION PROCESS

For the purpose of designating significant caves the Bureau of Land Management Field Office Manager is the authorized officer. Caves may be designated at any time and need not wait for a land use planning decision. If a cave meets at least one of the Significance criteria it MUST be designated as significant. If a cave is known but has not been inventoried for significance designation it shall be managed as if it were designated as significant until such time as an evaluation can be made. If a cave is inventoried and found not to possess one of the significance criteria it may be designated as significant if such criteria are later discovered.

A. Nominations

There are two processes by which a cave may be designated as significant. The first is through public nomination and the second is through an internal agency process.

1. **Public Nomination Process** - The public nomination process begins when a member of the public submits information about a cave they think may be significant and is located on Bureau lands. It is required that this information be held in confidence and not given out to the public. Once the public nomination process is completed the information is returned to the nominator.

   There is specific information that should be submitted to the BLM for a nomination. The information needed can be submitted on a work sheet or in a similar format. The BLM Significant Cave Nomination Worksheet may be used (Appendix 2–2).

2. **Internal Nomination Process** - The internal process involves the agency searching their existing records and information in their cave files and making a significance determination based on current information. It may also involve agency employees conducting fieldwork necessary to gather information to nominate a cave as significant.

B. Designation Process

Once a cave or list of caves have been determined to meet the definition of a "cave" and meet at least one of the "significance" criteria the list of caves along with the criteria that each cave met is signed by the Field Office Manager. The list is kept in the Field Office with the rest of the cave files. An example of the designation document can be found in Appendix 2–3.

C. Reporting

All significant caves should be reported in the RMIS (Recreation Management Information System). The significant caves reporting location is on the Recreation Management Area (RMA) page. To add significant caves; log in go to the RMA/Sites, There will be a line that says "RMA:" and a drop down list. Below that there is a line that says "Name". You may have one that says Caves. If not, you may create one. The site you select from the drop down list will show up in blue underlined to the right of "Name". Six lines down there is a heading "No. (#) of Significant Caves". Click on the blue underlined RMA you selected in the 2nd line down. This screen will allow you to edit your numbers and add the number of significant caves.

D. Inventories

Cave inventories and maps form the basis on which management decisions are made and plans are written. The sooner inventories can be performed and base line data can be gathered the better. This will supply a starting point from which future management actions can be measured and the success of management decisions can be judged.

There are many different types of inventories. Some can be very specific to a particular resource such as mineralogy, biology, geology, and the like. A basic type of inventory system is using the significance criteria found in 43 CFR Part 37 to evaluate significant cave determinations. This is a very basic approach. Some inventories can be conducted independent of other actions, while some inventories may be tied to survey and mapping projects. It is not uncommon for a specific biological, geologic, or mineralogic inventory to be conducted as a stand-alone mission.

Whatever inventory form you get, it can always be modified to suit your needs and the specific cave features for your area.

An inventory form intended to use during cave cartographic surveys can be found in Appendix 2–4. At each survey station the inventory person marks the station number beside each of the features that occur in that area. This information can be put in a database.

Chapter 3: Resource Planning

I. WHY LAND USE PLANNING IS IMPORTANT

- Plans provide guidance for actions when implementation is ready.
- Plans provide the basis to restrict other uses that may adversely impact significant cave or karst resources.
- Plans provide an avenue and process to obtain funding.
- Plans establish priorities.

II. THE LAND USE PLANNING HANDBOOK

The BLM Planning Handbook 1601–1 provides a basic outline of the sections that should be included in a basic cave and karst resources management plan. This can be found in the 1601 Planning Handbook, Appendix C, Page 13, Part L as well as in Appendix 3–1 of this handbook.

A. Management

Resources, Visitors, and Facilities

This section identifies the basic resources being managed such as biologic, geologic, hydrologic, mineralogic, paleontologic, cultural, etc. and their relative importance. It also identifies types of visitor use such as recreational, scientific research, or educational and the types of facilities being used as management tools such as gates, fences, roads and trails, and interpretive media.

B. Marketing

Outreach, Information and Education, Promotion, Interpretation, and Environmental Education

This section describes the amount and type of public outreach the cave/karst program will promote. It should include basic strategies for levels of promotion for the program and the types of interpretation and environmental education that will be developed such as brochures, websites, and interpretive kiosks. It should identify both internal and external outreach and coordination. Coordination with internal programs such as wildlife, recreation, grazing, minerals development, etc. should be identified. Outreach to external partners such as the National Speleological Society, The Cave Research Foundation, and others should be identified.

C. Monitoring

Social, Environmental, and Administrative Indicators, and Standards)

This section should identify what kind of monitoring programs will be conducted and on what frequency. Elements to be considered would include: visitor use monitoring, resource damage monitoring, biological community monitoring, environmental monitoring (temperature, water levels and quality, air flow, humidity, etc.). Monitoring programs should be developed based on what the administrative goals for the program are and for individual caves.

D. Administration

Regulatory, Permit/Fee/Fiscal, Data Management, and Customer Liaison

This section should outline what type of regulatory controls will be applied to protect cave and karst resources. These may include withdrawal of lands from mineral entry, closure to mineral material sales, limiting access, and requiring entrance permits. This section should also identify what type of data management will be established for cave and karst resources information and data generated. This may include: filing cabinets with individual cave files, electronic copies of the cave files (highly recommended as a backup system), GIS files of cave locations (only key personnel with access to the data), photo files, map files, and others. This is also where MOUs, Cooperative Management Agreements, Assistance Agreements, and Interagency Agreements should be identified.

III. THE RESOURCE MANAGEMENT PLANNING PROCESS

The inclusion of cave resources in land use plans and the planning process is required in the Federal Cave Resources Protection Act of 1988. Additionally, current BLM policy outlined in the 8380 Manual for Managing Cave and Karst Resources (see Appendix 3–2) expands this requirement to include karst lands and to identify unacceptable risks to identified cave and karst resources through the planning process. There are two primary levels of planning that can provide overall resource management guidance. Broad scale programmatic planning takes place at the Resource Management Plan (RMP) level and cave specific details, which are covered at the activity planning level. The RMP planning level supplies the basis of activity management plans.

The first part of the RMP planning process is to write the pre-plan. This section is designed to review existing plans and identify issues and areas that may require special management actions to provide adequate protection related to cave and karst systems.

The next step is the Analysis of the Management Situation (AMS). The AMS is designed to do three things; 1) Systematically describe the cave and karst environment (chapter 2), 2) Review the existing management plans and pull out those specific actions related to cave and karst resources and decisions (chapter 3), and 3) Look at opportunities to address new issues or expand, improve, or protect karst resources (chapter 4). These basic elements are then rolled into the appropriate chapters of the RMP and are used to develop alternatives. An example of an AMS can be found in Appendix 3–3.

Early in the initiation of the planning process it is required to hold public scoping meetings. These meetings are to gather public input and identify specific issues the public is concerned with. The caving community often has specific issues they would like to bring forward and can be a very positive asset to developing a sound and supported management plan. It is a good idea to notify them and invite them to participate in the process from the beginning. Some good ways to notify the caving community is to post notices in the local and regional newsletters, on internet news feeds, and to give a talk at the local grotto meetings.

Special designations such as Area of Critical Environmental Concern (ACEC) may be given to certain karst areas for protection of important groundwater recharge areas, caves or groups of caves that have been designated as significant in accordance with 43 CFR Part 37. If ACEC designation is sought, the areas must meet specific requirements set out in the ACEC Manual 1601–3 .1. These requirements are: Relevance – 1) Significant historic, cultural, or scenic properties, 2) Fish and Wildlife Resources, 3) Natural processes or systems, 4) Natural hazards. The second requirement is Importance – 1) More than locally significant, 2) Fragile, sensitive, rare, irreplaceable, exemplary, or unique qualities, 3) Recognized as warranting protection, 4) Has public safety or welfare issues.

Other designations may be given to identify significant caves or karst areas such as The Capitan Reef Karst Groundwater Protection Area or other appropriate title. These areas would be identified based on resource inventories, available resource information, and the need to provide some type of special management actions or protection.

The RMP is accompanied by an Environmental Impact Statement, which has specific requirements for public involvement and review. In this way the caving community is afforded an opportunity to review and comment on the proposed alternatives. It is recommended that the caving community be brought in early during the scoping process and their recommendations be sought in the development of the proposed action and alternatives.

IV. LINKING THE PLANNING PROCESS TO THE BUDGET SYSTEM

The budget process can be complex but a basic understanding is important in acquiring funds to implement your planned actions. Budget planning is broken down into 4 segments—the Current Fiscal Year (FY), the Budget Year, the Program Year, and the Out Years.

In the Current fiscal year there is very little opportunity for any budget changes. Congress has already approved the budget and the appropriations have already been made. Annual Work Plan commitments have already been determined. The most proactive thing to do during this time is to begin writing up your proposals for submitting later.

The Budget Year is the current fiscal year plus a year. In the Budget Year the administration has decided on the budget but Congress has not approved it yet. This is a time when budget justifications are still being written and there are opportunities for add-ons and line item inclusions. During the middle of the year Congress begins their budget hearings. At the end of the FY Annual Work Plan decisions are made.

The Program Year is the current FY plus two years. This is the time when the budget is being put together. There may be opportunities for new initiatives and funding increases. Generally these are large increases of $500,000 or more that go to programs. It is a time to look at the future and start lining up your external support.

The Out Years are a time to dream. This is time to think about your program needs and begin formulating your budget needs and justifications.

It is important to understand that the BLM funds programs not plans. To increase the chances of receiving funding to implement plan project, link your budget requests to current Washington Office administrative program initiatives such as Youth initiatives, Recreation initiatives, Wildlife initiatives, Climate Change, and others. Be in touch with State Office and Washington Office budget contacts for information on what current and emerging program initiatives are. Work with other program leads to jointly accomplish program goals. If a bat friendly gate is planned for a cave coordinate with the wildlife program to help fund and accomplish the project. Be sure to generate external support to add to the budget proposals. External support and public input are essential in the development of successful proposals.

V. ACTIVITY PLANS

Once the RMP is complete and the overall management goals for the program are set it is time to begin developing the specific plans for individual caves, cave complexes, or significant karst areas. This is considered an activity plan and is accompanied by an Environmental Assessment for those actions that require one. The activity plan should include the following elements:

A. Location/Setting

Cave locations should be in the form of maps, written instructions on how to get to the cave, air photos, and GPS coordinates should be in the front part of the plan.

B. Background Information

This should include any necessary information concerning the cave or karst area that would be relevant to the management direction for that plan. Such things as the nature of any threats to the systems, particular fragile or sensitive concerns, the types of use that the areas receive should be included.

C. Goals and Objectives

The goals for management of a particular area should state what the overall intent or desired outcome for each cave or area is. For instance, the goal of management of this cave complex is to facilitate the understanding of the paleontological significance of the area in a manner that maintains the integrity of the resources there. The objectives would state how the goals would be met. The objectives of management are to encourage scientific investigations of the cave complex and encourage the scientific communities to engage in responsible excavations that disturb no more that 5 % of the estimated paleontological materials in the complex.

D. Description of Resources

The description of resources can begin as a general outline of basic elements that are found in the cave or karst area and then move into more specific details of inventory results and reports. The basic inventory elements tied to the significance criteria found in 43 CFR Part 37 can be used to help describe the resources. More in-depth inventories on additional elements that may be particular to that cave or karst area can always be added. (See Inventory Form in Appendix 2–4)

Information should be arranged based on importance and relevance, such as vulnerable cultural or paleontological features, threatened or endangered species, fragile speleothems, and so on. This information can then be easily pulled for use in management plans and decision-making.

E. Issues Identification

Any issues or threats that may affect a cave or karst area should be identified. It is important to identify the source of the threat or issue and project what the long-range outcome may be if the threat or issue is not mitigated. Issues can be a result of internal cave management decisions such as number of cave permits issued or number of people per trip and the visitor-use impacts that are being seen. Issues can also result from external pressures such as increased minerals development encroaching on a karst area and the threat to local groundwater supplies.

F. Management Prescriptions

Management prescriptions should be developed which address the identified issues. These may also be incorporated from the Resource Management Plan. Management prescriptions or directions can be in the form of administrative controls, physical controls, regulatory actions, conservation initiatives, public education and outreach, and others. For more detail see Chapter 5: Implementation Strategies.

G. Safety/Search and Rescue Plan

Included in a cave specific activity plan should be the identification of any known risks to visitors. This may include dangerous or poisonous insects or snakes, possibility of flooding, drops, difficult access routes, or any other situation that could pose a risk or possibility of injury to the visitor including BLM personnel. If the risks are sufficient enough, a search and rescue plan for the cave should be developed. This section of the plan should be readily available so in the event that a rescue is required the details may be quickly accessed. A complete set of Cave Safety Guidelines detailing the Job Risks Assessment and mitigations and how to design a cave search and rescue plan can be found in Chapter 5–H.

H. Monitoring

All activity plans should include a specific monitoring plan to systematically evaluate the success or lack of attaining the management goals and objectives. Monitoring plans can be specific to individual caves or can be tied to a system or complex of caves or karst area that may all have the same goals and objectives. Various aspects of monitoring can target biological communities such as bats, visitor use and impacts, water quality and quantity, and other elements relevant to identified cave or karst resources. Monitoring evaluations should

occur at a minimum of annually to be able to determine where management interventions need to be increased or modified and where they are being successful. A complete section on monitoring can be found in Chapter 5: Implementation Strategies.

I. Maps

Maps are one of the first and most important tools for managing caves and karst resources. This is particularly true in the case of large or complex cave systems. Maps help the manager see spatial relationships between resources and make it easier to make decisions regarding visitor use or development of sensitive karst areas. Maps can be used to highlight sensitive areas of caves or karst areas for avoidance or can show where impacts have been taking place. In each plan topographic maps should be used to show where the cave or karst area is located and where the sensitive areas are to avoid. Cave maps should be tools to assist the manager in making informed decisions. If cave locations are marked on maps in karst areas it is important that those maps be kept confidential in accordance with the Federal Cave Resources Protection Act. Additional information on maps and mapping can be found in Chapter 5: Implementation Strategies, Section IV Cave/Karst Surveys.

J. Research and Data Trends

This type of information may be important to reference in an activity or management plan to give credibility or rationale for management decisions and actions. It may not be necessary to include the entirety of the research but only an excerpt or reference.

An example of a cave management plan can be found in Appendix 3–4.

Chapter 4: Integrating the Surface and Subsurface

Caves and karst environments are part of an overall landscape and as such what happens on the surface can affect the subsurface and what goes on in the subsurface can also have an effect on the surface. Therefore it is critical that cave and karst resources management always consider surface activities and their potential impacts to the subsurface resources and environments and vice versa.

I. LOCATING CAVES AND KARST AREAS

You can't adequately manage for something if you don't know where it is. Knowing where your significant karst areas and caves are is vital in developing a successful program. Locating caves and significant karst areas is essential to:

- Protect resources from theft, vandalism, and careless damage.
- Eliminate or reduce threats from adverse human surface activities.
- Reduce potential hazards caves may present to visitors and surface users (geohazards).
- Gain a better understanding of the natural environment we are responsible for managing.

The first thing to do is search existing sources.

A. Files

A search of existing files can be a quick and easy way to get started. Many of the different programs and program specialists have files that may have valuable information about caves and karst locations. Some of the different programs to look at are:

1) Cultural Records
2) Range and Timber Files
3) Recreation Files
4) Wildlife Records
5) Minerals Records
6) Engineering Files
7) Law Enforcement Files

B. Local Sources

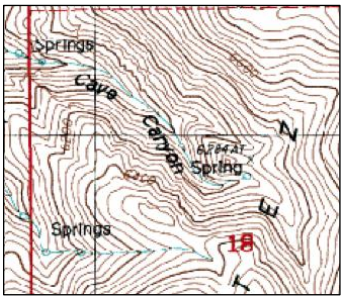
It may also be very productive to get in touch with some of your local sources. They may be able to provide some of your best information. Local sources may be:

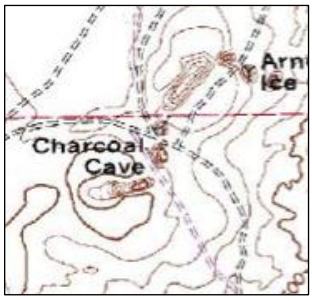
1) Local Cavers, Ranchers, Loggers, Well Drillers, Hunters, Hikers, and Riders.
2) Local SAR, Law Enforcement, Wildland Firefighters.
3) Geological society, Newspapers, Local History Books, and Articles.
4) Library
5) Community Elders

All of these people are out in the backcountry and may have come across caves or sinkholes. They may be willing to share their information with you.

C. Maps

The most useful are geologic and topographic maps. They are essential in understanding the settings and potential impacts to cave and karst systems. They can also be very valuable tools in finding caves. On geologic maps looking for areas of limestone, gypsum, or lava flows can be a major asset in locating potential cave and karst areas. Search for features with cave names. The US Geological Survey has come out with the most recent Karst Map of the United States. It is available on line at *http://dx.doi.org/10.3133/ofr20141156*. This is a great tool to use when checking cave and karst potential in your area and to see what adjoining agencies may have that would provide opportunities for cooperation resource planning projects. The map also contains information on lava flows and lava tubes. These are downloadable GIS files and topographic maps. Look for sinkholes, sinking/ephemeral streams, springs, and vegetation anomalies.





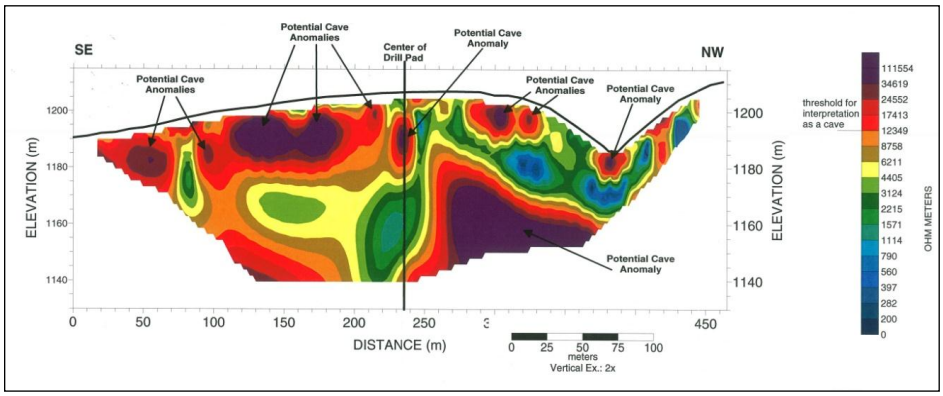
D. Remote Sensing

There are several types of remote sensing that can be used to locate caves.

1. **Satellite Imagery** (Google Earth, Bing Maps) - Digital Ortho Quarter Quads (DOQQs) – Air Photos. This type of imagery can help visually locate potential caves and karst areas.

2. **Thermal Mapping** - Infrared (IR) imagery has long been used to measure temperature variations of the earth's surface. Warm air blowing out of cave entrances on cold winter days can be spotted by scanners.

3. **Geophysical Methods** - Resistivity, Ground Penetrating Radar, Microgravity, Seismic Detection—these types of remote sensing can be used where caves may be suspected but not known. They are particularly useful where drilling or excavating projects may encounter caves or cause objectionable runoff into karst aquifer recharge areas. Road building and other construction activities in karst areas may present very real geo-hazards during construction and even after completion due to constant vibration and load bearing causing eventual collapse. Each of these geophysical methods has its' own limitations but can be used when appropriate.



Resistivity print out showing locations of caves under proposed drilling location.

II. EXTERNAL THREATS TO CAVE AND KARST SYSTEMS

Managing karst lands is particularly tricky when it comes to understanding the interconnected nature of the surface and the subsurface. Little can happen on the surface that won't have an effect on the subsurface. Likewise, those things in the subsurface can have dramatic effects on surface activities. It is critical that the cave/karst manager gains awareness of these connections and learns how these two environments interact with each other.

A. Water Contamination

In karst lands surface water can move very rapidly into the groundwater system without going through any filtering through the overlying soils. This can transport any contaminates or harmful runoff directly into the groundwater system.

B. Disruption of Surface Environs

It is important to pay close attention and monitor where roads, pipelines, drainage ditches and diversions, or any other such surface disturbing activities are being proposed. All of these activities have the potential to alter the natural flow of water into or out of sinkholes or cave entrances. This may affect the biological communities of the cave system by cutting off the input of nutrients into the system or by increasing the natural flow and siltation of the cave environment. As well, it may introduce pollutants into the groundwater and any springs it feeds. Clearing of vegetation around sinkholes and cave entrances can also increase sedimentation and adverse impacts. Because caves maintain a constant temperature year round and because they have a constant exchange of air with the surface, the entrance areas can create a zone that is cooler in the summer and warmer in the winter. This special micro climate can produce a greater diversity and density of plant species and hence a greater diversity and density of animal species using that habitat. Vegetation around cave and sinkhole entrances also filters much of the sediments that would otherwise enter the system.

C. Sources of External Impacts

Any type of development can be a source of potential impact to karst systems. This can include the development of industrial or residential areas encroaching on karst lands, golf courses, agricultural development, and other such developments. All of these have similar effects by increasing pavement run-off, decreased infiltration, increased flooding, increased sedimentation, and potentially increased contaminants entering the subsurface ecosystem. Any such developments over karst systems can also increase the possibility of geo-hazards and catastrophic collapse.

1. Roads can create impacts when storm water runoff is routed into karst features, when spills or other contaminants such as radiator fluids, leaking oil and break-fluid drain into karst features, and when the roof of the cave collapses creating a significant geo-hazard.

2. Illegal dumping in cave entrances and sinkholes cause groundwater contamination, is harmful to cave life, and is hazardous to visitors. Dumping of brine or produced water from oil and gas production on roads can run off into cave entrances and karst features which can pollute karst aquifers.

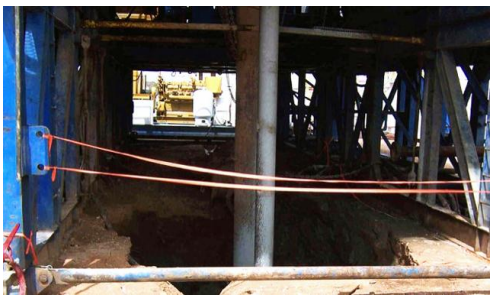
Illegal dumping in caves can be hazardous to visitors, cave life, and water supplies.

Contaminated water dumped on roads can enter karst aquifers.

3. Logging in karst areas can increase sedimentation as a result of the decrease in surface cover. Changes in a caves' water chemistry can be affected by increasing the acidity created by excess tannins from decomposing slash piles and debris entering sinkholes and cave entrances. This can adversely impact the wildlife of the cave ecosystem.

   If slash is deposited in cave entrances and swallets it may plug the entrance and/or prevent the natural inflow of clean water.

4. Oil and gas drilling and production operations can cause increased surface disturbance from road, pad, pipeline, and power line construction thus causing increased sedimentation and potential for spills entering the karst ecosystem.



Catastrophic collapse underneath drilling rig.

Catastrophic collapse of tank into subsurface void.

Drilling fluids can enter the caves and karst aquifers during drilling operations and as a result of leaky casing during production. Hydrocarbons and other pollutants can also enter the karst systems during production operations from leaking tanks, pits, and pipes. Spills from trucks and other activities can also enter and contaminate karst aquifers and ecosystems. Catastrophic collapses of drilling equipment and production facilities into shallow caves present a serious geo-hazard in some areas. Attaching special notices and stipulations to the leases can be a first line of protection. Examples of these can be found in

Appendix 5–32 and 5–33. More specific protective measures can be given by attaching conditions of approval (COAs) and downhole drilling, casing and cementing requirements to the Applications for Permits to Drill (APDs). Examples of drilling, casing, and cementing procedures and conditions of approval for Drilling permits can be found in Appendix 5–31.

5. Grazing activities may affect karst resources if livestock have access to areas of karst water recharge such as sinking streams or resurgences. In these cases water may be pumped or piped to tanks or troughs away from these critical water supplies and the springs and insurgencies may be fenced off. (Grazing Permit Renewal Language is in Appendix 5–34)

6. Mining and mineral materials sales can have a devastating effect on caves and karst systems if not recognized and properly mitigated. Mining and mineral excavation operations can intersect caves and cause changes to stable environmental systems such as temperature, humidity, and airflow. Mining activities can introduce dust and other contaminates into the system and in extreme cases mine away the caves themselves. Leachates from tailings ponds can enter into karst water supplies and contaminate habitat. In certain situations pumping of water out of karst aquifers for mining purposes can dewater those aquifers and remove critical habitat for troglobitic species. Environmental assessment language detailing more impacts can be found in Appendix 4–2.

III. INTERNAL THREATS TO CAVE AND KARST SYSTEMS

Cave and karst environments can be easily disturbed by unintentional actions. Not understanding the resource can lead to the mismanagement of caves and karst lands. One of the most important tools a cave manager can have to increase their understanding of the cave and karst systems is a good map of the cave and a comprehensive inventory of the in-cave resources. Resource inventories let the manager know what there is to manage in the cave and maps are essential for a manager to understand where the cave resources are and how best to protect the most sensitive ones. Maps can be valuable tools in laying out visitor use trails and avoiding sensitive habitats that can be easily disrupted.

Developing a better understanding of the cave resources and their condition can help avoid a number of problems such as:

A. Soil Disturbance and Compaction

This disrupts the action of small troglobitic species that need loose fluffy soils to lay their eggs in. It also can prevent certain mineral growth such as gypsum crystals and may disrupt or destroy certain archeological remains.

B. Disruption of Species Habitat

Interfering with roosting bat populations and other species that are sensitive to human traffic.

C. Introduction of Contaminants

This can be in the form of trash, spilled food, introduced bacteria and other microbes into the cave. It can also be in the form of pollutants filtering into the cave system from the surface.

D. Visitor Use Impacts

Visitor use can cause problems with soil compaction, habitat disturbance, and introduction of contaminants as well as other direct impacts such as broken formations and graffiti. An environmental assessment addressing visitor use impacts can be found in Appendix 5–28.

E. White Nose Syndrome

White-nose syndrome (WNS) is a disease affecting hibernating bats. It is named for the white fungus that appears on the muzzle and other parts of the bats. WNS is associated with extensive mortality of bats in eastern North America. First documented in New York in the winter of 2006–2007, WNS has spread rapidly across the northeastern and southeastern United States and Canada.

Bats with WNS act strangely during cold winter months, including flying outside in the day and clustering near the entrances of hibernacula (caves and mines where bats hibernate). Bats have been found sick and dying in unprecedented numbers in and around caves and mines. WNS has killed more than 5.7 million bats in eastern North America. In some hibernacula, 90 to 100 percent of bats have died.

Many laboratories and state and federal biologists are investigating the cause of the bat deaths. A newly discovered fungus, Pseudogymnoascus destructans, or pd, (formerly Geomyces destructans), has been demonstrated to cause WNS. Scientists are investigating the dynamics of fungal infection and transmission, and searching for a way to control it.

Scientific data collected to date indicates that transmission of WNS is occurring bat-to-bat and cave-to-bat. Scientists also suspect transmission of WNS may be facilitated by human activity in caves where bats hibernate and roost. This is because of the geographically discontinuous spread of the syndrome. People may be inadvertently transporting fungal spores from cave to cave, as fungal spores have been detected on gear exposed to affected sites. The BLM recognizes that there are knowledge gaps concerning WNS etiology and epidemiology; however, we are committed to implementing measures to prevent and reduce the impacts of WNS. The BLM may adjust its policy on WNS as more information becomes available through ongoing monitoring and research efforts.

In 2010 the BLM issued WO Instruction Memorandum 2010–181 (Appendix 4–1) to give national direction on how to prepare for the anticipated occurrence of white-nose syndrome. The BLM-WNS Interim Response Strategy includes guidance on:

1. **Stakeholder Coordination:** Coordinate and conduct outreach with appropriate internal and external stakeholders to prevent or contain the spread of WNS. The White-Nose Syndrome Organization (WhiteNoseSyndrome.org) is an interagency organization that works at several levels in trying to understand the disease, coordinate management, conduct outreach, and develop response plans. Their web site has much of the most resent information concerning WNS.

2. **Identify Sites with Important Bat Resources:** BLM offices will utilize the best available scientific information to assess and identify sites on BLM-administered lands that have important bat resources.

3. **Emphasize Ongoing Inventory Efforts:** Emphasize ongoing inventory efforts of Abandoned Mine Land Program Surveys.

4. **Site Administrative and Physical Closure:** Consider restricting access to caves and abandoned mines on BLM-administered lands in your state. It is suggested that BLM State Directors use a targeted approach to closures that prioritizes sites with important bat resources.

5. **Identification of Potential WNS Surveillance Locations:** Utilize external partners in assisting with reporting the presence of the fungus and suspected WNS afflicted bats.

6. **Containment and Decontamination:** Adhere to the current version of containment and decontamination procedures. The most recent decontamination procedures can be found on the US Fish and Wildlife website at *www.fws.gov/midwest/Endangered/mammals/BatDisinfectionProtocol* or at the site *www.whitenosesyndrome.org/topics/decontamination*. These procedures may change over time and as more effective methods are found. Always check to see if there have been any updates on decontamination procedures.

7. **Research:** Where practicable and feasible within budgetary constraints, the BLM will participate in and support WNS research efforts.

8. **Outreach:** Participate in interagency groups to develop state WNS response plans that consider the Interagency National Response Plan, as appropriate.

Summary

The concept of "Out of Sight, Out of Mind" can create significant threats to cave and karst resources. Being unaware of the cave and karst resources beneath a manager's feet can create serious situations that can cause a multitude of systematic and internal cave problems. There are a few basic strategies to help eliminate this threat.

1. **Education** - Educate managers and users about resources and issues.
2. **Surveys and Inventories** - Conduct surveys and inventories of caves and karst lands.
3. **Research** - Conduct and invest in all the research possible involving your resources.
4. **Planning Documents** - Ensure cave and karst resources are considered in all planning and NEPA documents. Without adequate planning documents development can occur without resource considerations.
5. **Guidelines** - Be sure to look up and follow all existing cave guidance.
6. **Control Access** - Develop guidelines for cave entry and resource protection both on the surface and underground.

Chapter 5: Implementation Strategies

This chapter is the heart of the handbook. This is where most of the on-the-ground information relating to the "how tos" of cave and karst management is located.

I. PROTECTION AND CONSERVATION METHODS

A. Administrative

Administrative measures are those actions that can be put in place through management decisions or made through the planning process. These measures are generally the least stringent and do not necessarily require on-the-ground activities. Administrative measures can also provide the legal means to enforce management decisions.

1. **Signs** - Basic information on a cave entrance sign may include: the cave name and agency number, managing agency, permit requirements, regulation citations, and contact information. An example may be found in Appendix 5–1. More elaborate kiosks and interpretive signs are a good way to inform the public of general safety and ethics guides. They can be used to warn the visitor about possible risks of caving and how to avoid injury, provide them with specific information about the cave resources such as geology, cave ecosystems, water elements, and bats. A general information sign can also be useful in providing facts about cave life and safety. (Appendix 5–2)

2. **Patrols** - Regular patrols of cave areas can provide a presence that may discourage the abuse of caves. These may be conducted by either agency personnel in uniform or by volunteers.

3. **Provide Educational Tours** - Educational tours require a lot of time and effort to conduct but can be a powerful tool in educating the public and local caving interests about cave and karst resources and their management. Educational tours to school groups, civic groups, youth groups and the like may be a way to educate them in a way that will prevent future problems and vandalism.

4. **Brochures** - Brochures are a handy way to put a lot of detailed information out to the public. Brochures can contain information on Caving Opportunities, Fees, Cave Permits, Age Limits, Safety, Emergency Numbers, Natural History, Conservation, and specific information about the caves available for recreational use. This information can give elevation, hiking distance from trailhead, group size limits, seasonal closures, special risks, pits and rope requirements, and the sort.

5. **Public Contacts** - Maintaining good contacts in the local community is essential to gaining their cooperation in the event of any need. The Mayor, Sheriff's Department, Police Department, Fire Departments, Civic group leaders can all be a support to the cave program in their own way

6. **Public Involvement** - Talks to civic groups, presentations at schools, Public lands Day cave related activities, donating cave books to the library, Radio appearances, News announcements about science research and exploration being done.

7. **Cave Map Deletions** - Omit sensitive cave passages from maps given to the public.

8. **Caves Removed from Maps** - When possible remove cave locations from any maps that go out of the office. Make sure that any digital maps don't have any cave locations on them.

9. **Cameras and Surveillance** - Setting up surveillance equipment is a good way to track visitation and movement in the cave. This information can be used to document when visitations occur, hidden cameras set up in parking areas can get license numbers and auto descriptions. There is surveillance equipment available that detects light and records the date and time. These can be used to monitor for illegal entries.

B. Regulatory Actions

1. **Passage of Laws and Regulations** - Occasionally certain laws are passed that can be used to help regulate activities in caves. The Federal Cave Resources Protection Act of 1988 is such a law. Likewise, certain regulations can be effective in providing various protections for cave and karst resources. Many laws and regulations are referred to in Chapter 1 Section III. These give certain protection measures that can be applied to cave and karst resources.

2. **Mineral Withdrawals** - Mineral withdrawals are critical to protect caves and karst lands from the impacts of mining claims and the Mineral Leasing act. Once in place they are active for 20 years at which time they are reviewed and can be extended for another 20 years or relinquished. Mineral withdrawals can be extended any number of times. The process of initiating a minerals withdrawal starts with a Resource Management Plan decision approving the withdrawal action. The first step is to file a Petition Application for Minerals Withdrawal. An example of such a petition can be found in Appendix 5–3. If the area to be withdrawn is greater than 5,000 acres it will require Congressional approval. If the petition application is accepted then an environmental assessment should be prepared. An example is in Appendix 5-4. The final step is to publish the withdrawal notice in the Federal Register, Appendix 5–5. The full process can be found in 43 CFR Part 2300. The legal descriptions of the lands to be withdrawn do not have to be published in the Federal Register notice, as it would be a violation of the Federal Cave Resources Protection Act confidentiality section. Instead a statement can direct interested parties to the local field office for more information.

3. **Special Designations** - Through the RMP process sensitive cave and karst areas can be given special designations such as an Area of Critical Environmental Concern (ACEC). Management prescriptions for such designations can include any number of protection measures such as mineral withdrawals, closed to mineral leasing, closed to mineral material sales, OHV closures, and others. As well, caves may be designated as "Special Areas" in accordance with the Land and Water Conservation Fund Act and may require the issuance of a Special Recreation Permit (SRP) for "use of special areas" under 43 CFR 2932.11(b)(iii). This can be done via an Instruction Memorandum as in the example in Appendix 5–6. The issuance of SRPs is discretionary. Specific cave and/or karst management plans or designations can also be used to apply protective administrative measures such as seasonal closures to protect bats.

4. **Cave Closures** - Federal Register Notice - Once a decision is made to close a cave it is required that the closure be published in the Federal Register to make it legal and provide law enforcement the authority to act upon violations. See appendix 5–7 for example. Notices should:

   a) State Authority

   b) State what the lands are being closed from, Unauthorized Entry

   c) State which caves are being closed (no locations should be given as per the FCRPA)

   d) Where permits and additional information may be obtained

5. **Supplemental Rules** - Any special conditions can be placed on use to protect resource values. The requirement to follow the most current decontaminations procedures for White Nose Syndrome has become a special condition of use for many caves across the country. Supplemental Rules may be established through an RMP process or can be established independently. If done independently the rules need to be published in the Federal Register and made available for public comment.

6. **Requiring Permits** - Permits are a good way to regulate access to caves. Chapter 5. Section II. C. details Permits and Permitting Systems.

7. **Law Enforcement** - The use of law enforcement rangers, when available, is a great deterrent to cave vandalism and break-ins. It is best to inform the rangers of the cave locations that are most vulnerable or historically have the most problems. Offer to take them caving and educate them on what the most sensitive resource concerns are. Set up a schedule of the best times to patrol. This can be based on data gathered from visitor use recorders such as light detections sensors that record the day and time that light strikes the unit. If that is during an authorized permit no worries. If it is during a time when no permits have been issued then there may be unauthorized use occurring. There are several laws and regulations that a law enforcement ranger can use to cite violations. Many of these can be found in Chapter 1. Section III. Laws and Regulations.

C. Physical Means

1. **Managing Access Points** - Through managing access points, caves and karst resources can be effectively protected. This can be an easy way to avoid unwanted visitation. There are several ways to manage access points.

   a) **Road Closures** - Closing roads that lead to sensitive cave locations or significant karst areas can be closed by using orders posted in the Federal Register. This gives law enforcement the legal authority to stop unauthorized vehicles.

   b) **Trails to Caves** - Managing trailheads that lead to caves can also be a viable way to protect caves. If a cave is not visited very often there may not be a lot of pressure to rehabilitate the trail leading to it.

   c) **Gates and Fences** - By far the most commonly used physical means of cave resources protection is the installation of a gate. Gates are an effective way of controlling access points and gaining control of visitor use by issuing permits. Once a determination has been made that a gate is the proper action a notice of closure needs to be prepared and published in the Federal Register (example in appendix 5–6). This gives law enforcement the authority to issue citations for illegal entry and other regulation violations (see Chapter 1 Section III Laws and Regulations). A resources inventory should be completed and an environmental assessment prepared to address the positive and negative impacts of the gate installation.

      Gates can cause significant negative impacts to wildlife and cave resources. There are lots of reasons not to install a cave gate and conversely there are some good reasons to install them. They can provide significant protection when all other attempts have been unsuccessful. The needs of the cave and the type of resources involved will dictate what kind of gate should be installed. Gates have a wide range of styles from buried boilerplates that completely block all airflow to large 4" angle iron "bat friendly" gates.

      The gate design should always strive to reproduce the natural airflow and access to the extent possible. If a cave was dug into and had no natural airflow upon discovery the gate design should create the same environment. If a cave has a larger entrance it needs to be designed to accommodate the natural passage of wildlife, to the extent possible.

      i) Why and When - Gates should be installed when there is the potential for damage to sensitive cave resources from uncontrolled visitor use. Another reason is for visitor safety. By installing a gate and requiring a permit the issuing office has an opportunity for personal contract and to inform the visitor of any specific risks and stipulations for that cave. A gate should be installed as soon as it is determined that either of these situations exists. There are also legal reasons to install gates that are covered under Permits in section II of this chapter.

      ii) There is an excellent publication by Bat Conservation International that gives detailed information and specifications for bat gate installation. The publication is titled Bats and Mines

but the gate designs work for caves as well. See Appendix 5–8 for Gate Design and Installation Diagrams.

iii) Fences can also serve as a means of keeping out cattle and honest people without interfering with the natural entrance. Fences should also be designed to allow for the natural passage of wildlife while still keeping out livestock and any undesirables.

Whenever gates and fences are used, it is a good idea to have information signs accompanying them. (See examples in Appendix 5–1 and 5–2)

d) **Passage Closures and Interior Gates** - A good way to protect interior portions of caves is to block the passage with rocks and/or camouflage the access. This may be easy for passages that are small but not practical for larger passages. Constructing interior gates within a cave is a common practice to protect sensitive areas of a cave. Interior gate designs also need to be well thought out and installed with as minimal impact to the cave environment as possible. Separate locks and keys/combinations can be issued to those sections. In these cases it is best to have a written policy that describes the access requirements. This may be having vertical experience, previous experience in that section of the cave, trip leader requirements, approved research/survey/inventory projects, and the like.

2. Cave Trails - The design and creation of trails within a cave is an excellent way to help protect fragile resources and still allow visitors to access major sections of the cave. Trails are an essential first step in reducing the cumulative impacts of large numbers of visitors into a cave and protecting fragile or sensitive cave resources. Trails should provide durable and safe walking surface and definite boundaries for visitors to stay within.

a) **Why** - Trails should be established for the following reasons:

i) To avoid unnecessary compaction of soils on the cave floor that provide wildlife habitat.

ii) To provide a durable surface that avoids sensitive or fragile resources such as cultural materials, speleothems, and wildlife or their habitat.

iii) To minimize routes which continue to widen or creep into areas that needs to be protected.

iv) To provide a surface that is raised out of the mud so visitors do not track mud from one section of the cave to another.

v) To provide the safest route through the cave for the visitor.

b) **Trail Layout and Design**

i) When possible, develop "one-way" trails through the cave. If visitors can be taken in one entrance and out another it will decrease the foot traffic through the cave by ½. Developing loop trails also allows the visitor to see more of the cave without having to back track.

ii) The most effective trails are ones that lead the visitor close enough to the major points of interest so they can see and photograph them but not so close that they can touch or disturb them.

iii) Trails should be marked on both sides to help clearly delineate the trail and confine new impacts to the previously disturbed and compacted pathways.

iv) To minimize impacts it is best to utilize those routes that have already been established, if they are well located. In some instances established routes may have to be relocated and the old route restored as best as possible to its original condition.

v) Trail width should be approximately ½ meter wide. If trails lead to a dead-end observation point it is best to have a larger open area for visitors to mill, observe the attractions, take photos, and then return along the same route to the main trail.

vi) New trail sections should be established only on durable surfaces with the promise of less impact to natural and cultural resources.

vii) Trail lay out is best done after becoming very familiar with the cave and its' resources and recognizing which areas could be shown and which ones should be avoided. A detailed cave map is a great asset in laying out trail systems. If a map is not available an individual familiar with the cave and its' resources could provide the needed information.

viii) Care should be used in laying out trails to avoid putting the visitor too close to hazardous areas such as drop offs or pits. When considering trail location be sure to watch out for low hanging rock projections and formations.

c) **Trail Construction Materials and Techniques**

i) It is best to use materials that do not rot, mold, mildew, rust, or leave other biodegradable residues. This will avoid introducing large amounts of unnatural food sources into the cave environment and falsely raising the food base of the animal species native to the cave. Surveyors flagging tape has long been a standard for marking cave trails. However, it is often eaten by cave crickets and leaves tiny bits of confetti sized plastic bits all throughout the cave, which is very difficult to remove. Avoid it if possible.

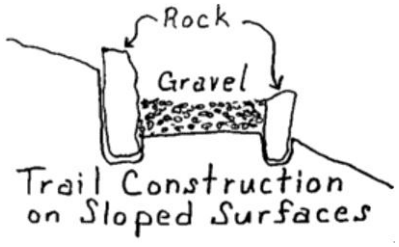
ii) For trail construction in areas with soft floors rocks can be used to line either side of the trail if they are available. PVC pipe can also be used as stakes and ¼ inch polypropylene cord or fiber metal tape strung between them. The stakes should be spaces approximately 3 meters apart and rise approximately 30–40 cm above the floor. The trail width should be approximately ½ meter wide.

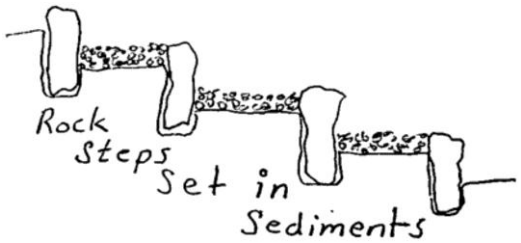
iii) The cord used should be highly visible. Either day-glow orange, yellow, blue, or other "hot" color.

iv) At times it may be necessary to install/construct ladders, stairs, or short bridges. These should be done with great care so as not to create additional safety hazards. Hand lines can also be used in some areas.

v) In areas where stakes cannot be used (i.e. solid rock or flowstone floors) small cairns of rocks may be used to support the trail cord. The cord can be looped around the top rock and strung to the next cairn. Another technique is to use existing nubs or protrusions to loop the cord around. If using this technique care should be taken not to damage any formations.

vi) In areas containing high amounts of mud, the trail can be raised to keep the visitors shoes cleaner and avoid tracking mud into other areas of the cave that may be clean. This can be done using natural stone or other natural material that will not have a negative impact on the cave environment. Below are some diagrams that show different construction techniques.





Building trails becomes an art and is an evolutionary process. Trails can be rerouted where it is determined that they are not being effective. New trails can be installed and old ones retired. It should be an on-going process of monitoring and evaluation until the best trail design and construction for each situation is achieved.

3. **Hiding Entrances** - Hiding an entrance can be an effective way to relieve some of the pressure on a cave or a portion of a cave. Disguising an entrance or rocking up a passageway to camouflage access can help limit the traffic into an area. Just be sure any restriction to the entrance or passage does not interfere with wildlife or other natural processes.

D. Education and Outreach

This section describes the amount and type of public outreach the cave/karst program should promote while being in compliance with the Confidentiality requirements of the Federal Cave Resources Protection Act. As such, specific cave locations and directions should not be published or given out to the general public. Marketing strategies refer back to the planning handbook and in the 8380 Manual.

Field office strategies should include basic levels of promotion for the program and the types of interpretation and environmental education that will be developed such as brochures, websites, interpretive kiosks and the messages given to the public. It should identify both internal and external outreach and coordination. Coordination with internal programs such as wildlife for species population monitoring and inventory, recreation for visitor use and restrictions, grazing for insurgence and resurgence enclosures, minerals for lease stipulations, withdrawals, and closures, etc. should be identified.

Outreach to external partners such as the National Speleological Society, The Cave Research Foundation, and others should be identified. When practical, agreements can be formed with these groups to further enhance their cooperation and input into the program.

When developing outreach material such as brochures, handouts, and other media it is ideal to provide educational information such as basic geology, biology, and other natural resource values. It is essential to convey conservation messages and outline appropriate behaviors on public lands and in the cave. These can follow Leave No Trace Skills and Ethics for Caving and for White-nose Syndrome awareness and decontamination as well as for camping in travel for the local area. Specific safety concerns should be listed for the local areas such as concerns for flash flooding, poisonous reptiles, hypothermia, and others. All of these increase the quality of the visitors' experience.

Engaging the news media in relation to cave events and issues can be a positive promotion of the program. It is critical to make sure the media receives the right story to avoid misinformation going out to the public. This can be accomplished by preparing new releases that give the facts surrounding issues, projects, and management decisions.

E. Permits and Permitting Systems

1. **Why and When** - If a cave is gated and the cave is still made available for recreational use, some kind of permit system is needed. There are several philosophies when it comes to permitting depending on the intensity and level of management involvement that is desired. Budget, manpower, and the availability of a specialist to administer the program may be some of the factors used in choosing which approach is

best for your situation. At one end of the spectrum is a high amount of management interaction in which permits would be required for all caves weather they were gated or not. And at the other end of the spectrum is a low level of management involvement, which would not require permits for any caves. There is also a middle ground in which some caves are permitted and some are not. At some point in the decision making process a determination must be made as to weather permits will be required and, if so, which caves should be part of the permitting system. This determination can and should be guided by the inventory for each cave.

There are several benefits of requiring a cave permit. For example, cave permits:

- Control Access
- Provide Resource Protection
- Provides Visitor Safety Awareness
- Provides Legal Grounds for Law Enforcement
- Provides Accountability of the Visitor
- Gives Opportunity for Visitor Contact
- Supplies Visitor Use Information
- Gives Opportunity for Visitor Feedback on Cave Conditions

Managing at the lowest level necessary (with the least management involvement) and still protecting the caves resources and public safety is an effective philosophy. This approach requires an entry permit only for those caves containing high resource values or safety risks. For these caves, management would need to maintain a higher level of control. Some of the situations which may prompt the use of permitting at this level might be: the presents of bat colonies that need seasonal or year round protection; a cave that has known health or safety hazards such as air bourn diseased or CO2 gas; highly fragile formations or ecosystems; or cultural remains to name a few. The advantage to this approach is that it puts the least amount of restrictions on the user by not requiring permits to enter all caves. This leaves the spontaneity of going caving in the hands of the caver. Additionally, it is less work for the manager. It requires less time commitment, less manpower, less gate installation and repair, and less money but still leaves the manager in control of the more sensitive cave resources.

2. **Variables** - There are several factors to consider when deciding on requiring permits.
    - Carrying Capacity: ideal number of visitors per day/month/year
    - Season of use: Summer, winter, year-round
    - Type of use: Recreational, Research only
    - Type of user: Experienced, inexperienced, technical, scientific
    - Cave hazards: Water, vertical drops, disease, hypothermia
    - Cave contents: Heavily decorated, no decorations, archaeological, paleontological

Once an approach has been decided upon there are a number of different permitting methods to choose from. For each permitted cave a resource evaluation or inventory should be conducted to determine which method is best suited for that cave. This evaluation and determination can be done using the information in the cave inventory records, from firsthand knowledge of the cave, and from consulting with those people who are most familiar with the cave. Once a permitting method has been selected, that doesn't mean it cannot change. If at a later date the management situation changes due to newly discovered information or

increased visitation, which has led to unacceptable impacts to the cave, that may require the cave to be reevaluated and a new permitting method established.

3. **Permit Contents** - The permit itself (example in appendix 5–9) should contain some basic information which includes: the name of the permittee, the cave(s) which they are authorized to visit, the authorized date of entry, the number of people permitted, and the signature of the authorizing officer. Signatures should also be provided by all those who enter the cave. Other items which might be useful to include on the permit are: The permitting authority, laws and regulations which protect caves, an indemnity clause, where and when to return the permit, and some **General Rules** of conduct in the cave. There should also be space on the permit for visitors to provide **Feedback** about their trip. This space may be several lines on the back of the permit. This information can provide cave managers with up to date information about the cave conditions, if the lock is broken, if there is new graffiti in the cave, if there are bats roosting there, if the cave is flooded, etc. Permits should be required to be returned.

   On the back of the permit should be an **Emergency Contact Number**. The emergency contact number may differ from state to state or from county to county. In some areas emergency response may be the responsibility of the State Police while in others it may fall to the county sheriff or a designated SAR group. It is best to find out before it is needed.

   Permits may be restricted in other ways. They can limit the number of persons entering the cave per trip and also limit the number of trips per week, month, or year. Establishing these "carrying capacities" or restrictions should be closely tied to the resource inventory and the vulnerability of the resources being managed.

   Special Risks and Stipulations Sheet (example in appendix 5–8) should be included with the permit. This sheet gives specific information about the risks and restrictions particular to that cave. It also has the combination to the lock on it. This ensures that the permittee has a copy of the special stipulations and risks prior to entering the cave.

   The object is to give the cave user the most information possible in order to make their trip safe and enjoyable, and provide the cave with the most protection. Providing information to the visitor about specific rules and risks before they enter the cave also significantly reduces the agencies liability.

   Should **anyone** who wants a cave permit be able to get one? That is a sensitive question involving liability and the rights of the public to use public land resources. One of the goals of a conscientious cave manager is to match the group to an appropriate cave. In this way the group will be less likely to inflict damage on the cave or to themselves as a result of inexperience. It also helps to ensure an enjoyable recreational experience.

   A screening process is a good way to try and fit the caving group to a cave that is best suited to them. The screening involves asking the applicant some basic questions concerning the experience level of their group. Questions such as: "How long have the members of your group been caving?" "What types of caves have they been in?" "What level of climbing experience do they have?" and "Do they have any vertical experience?"

   These types of questions will give the cave manager an idea of the competence level of the group and their leader. To some extent the group should be governed by the least experienced member. However, a certain amount of flexibility can be can be exercised. After the initial screening process, it may be a good time to suggest a particular cave that is suitable to that group. Of course, that requires that the person conducting the screening and issuing the permit knows something about the caves they are issuing permits to.

   One of the additional requirements that should go with every permit is an information sheet on White-Nose Syndrome and what the current decontamination procedures are. It should be made clear on the permit that properly decontaminated gear is a requirement for entry into a BLM cave and gear should be decontaminated after exiting.

4. **Types of Permits** - The following are some of the different permitting methods that may be applied.

   a) **The General Permit** - This is probably the most common type of recreational permit issued. It is primarily used to authorize access to caves, or sections of caves, which are not particularly subject to unintentional damage. Other than the standard types of stipulations and requirements of all permits there are few other restrictions.

   b) **Trip Leader Permit** - This type of permitting requires that the trip leader (the person to whom the permit is issued) must have been to the cave a certain number of times in order to qualify for being issued a permit. The documentation of their visitation is easily acquired by looking at the signed and returned permits of their previous trips. This method can be used for caves that have moderately high resource values, which may be subject to damage by the casual or unobservant user. The purpose of the trip leader is to thoroughly explain to the group all the areas to be careful in and ensure compliance.

   c) **Designated Trip Leader** - The designated trip leader is the next level of protective permitting. In this method the agency designates specific people who are accepted as trip leaders for that particular cave. A list of these people is kept in the caves' case file. This method may be used for caves, which have highly sensitive or fragile resources that are easily subject to damage. The individuals that are accepted as the designated leaders should be very accomplished cavers who know the cave intimately and can effectively serve as a trip leader. That means that if the trip leader feels that the group or a member of the group is not up for the trip then he may cancel the trip or ask the individual not to go with the rest of the group.

   d) **Guided Trips** - With guided trips a member of the agency leads the group. The purpose for guided trips is to provide the visitor with specific management guidance such as in caves having unique and highly sensitive resources or during restoration trips, mock rescues, collection trips, or on any trip where close supervision is necessary. The guided trip is by far the most costly to the agency in terms of manpower and money, however, it can also be some of the most rewarding to the visitor in terms of the personalized environmental education that can be given and the opportunity to develop good cave stewards.

      It is often convenient to have a cave entry application (example in appendix 5–11). This allows the agency to get a limited amount of information about the visitor, such as: name, address, home and day-time telephone numbers, who to contact in case of an emergency, what caves they want to visit and their preferred and alternate dates, and signatures of the parent or guardian of those who are under 18 years old.

5. **Database Permitting System** - Database permitting systems can provide some very convenient advantages as long as your computer systems don't break down. For that reason it is always good to have the old fashion paper back up version. A database system will automatically assign permit numbers, attach Special Risk and Stipulations sheets, White Nose Syndrome information, and lock combinations. They can also generate reports on number of permits issued; per cave, per year, per quarter, and number of visitors permitted. This is very convenient for yearend reporting.

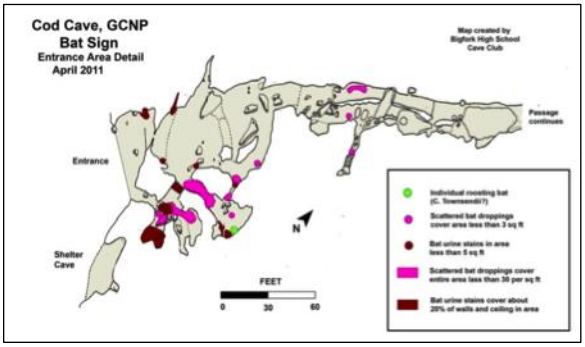
II. MONITORING

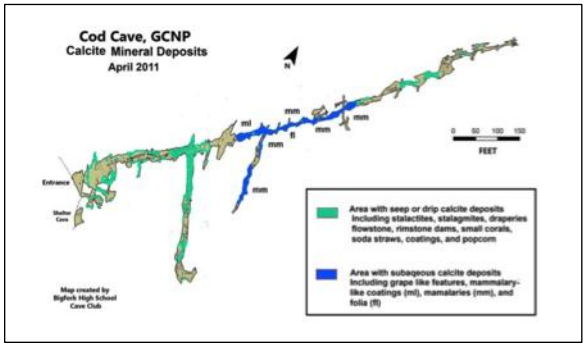
A well-designed monitoring program is essential to ensure that management goals and objectives are being met and that cave and karst resources are being protected. Monitoring can provide historical documentation of new discoveries and record resource conditions needed to assess long-term impacts and changes. It is important to identify the resources that have been inventoried in the cave and then determine what kind of monitoring program needs to be established. Monitoring systems should be easy to deploy in the field and be easy to repeat by field technicians or volunteers. Resource monitoring can document both positive and negative changes in the resource. It can clearly show success stories of restoration projects and effective management practices as well as other natural changes such

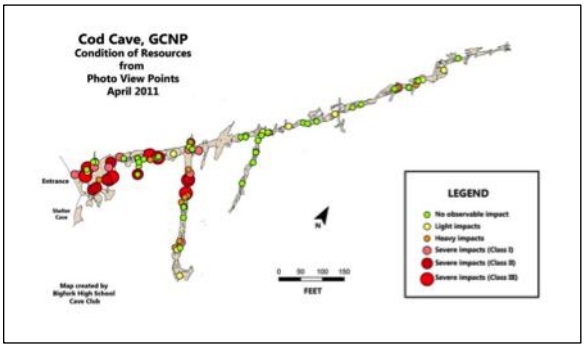
as the effects of floods or collapse. It can also document vandalism and over use. There are several different types of monitoring system available that can be used to track changes in resources. Some are better for certain resources than others.

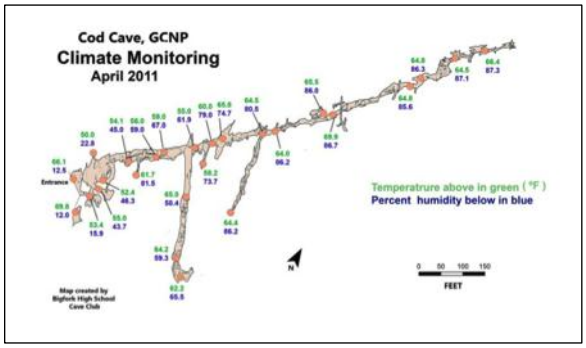
A. GIS Monitoring and Inventory Systems

All of the resources and changes being monitored can be entered into a GIS system as separate layers on top of a base map of the cave. This makes it easy for managers to look at multiple resource conditions and decide on effective management approaches. The various layers can be hyperlinked to photos, graphs, tables, reports, and other data relevant to that resource. Biological inventories, Visitor use impacts, Microclimate data, Water resources, Mineral resources, Cultural and Paleontological resources can all have their different layer in such a GIS inventory system. Below are examples of this type of GIS monitoring and inventory maps. Used here with permission from Hans Bodenhamer.









Specific things to monitor can be broken into two basic categories, Resources monitoring and Visitor Use Impacts. They may include; the condition of the cave entrance, delicate speleothem areas, paleontological or archeological deposits, biological communities including bat roosts, water resources including water levels and water quality, microclimate, and visitor use impacts. Of course, other resources may be added as needed.

B. Visitor Use Monitoring

1. **Photo Monitoring** - Photomonitoring can be used to document almost any resource. It is easy to conduct and easy to repeat. Photomonitoring point locations should be placed on a cave map specifically for that purpose to ensure photo point locations are consistent. Compass bearings and vertical angles should also be noted at each location to be sure that the photos are always taken in the same direction and vertical attitude. When possible it is best to have the photo points surveyed into known points on the cave survey. Cataloging and organizing the photos is critical in being able to use them to track resource changes. A good inventory outline to follow is by Cave Name; Date; Location in the cave, and Photo location number. If possible earlier print or slides should be scanned in and stored electronically.

2. **Limits of Acceptable Change** - Limits of Acceptable Change (LAC) is an objective method of documenting the changes to the cave environment caused by visitor use. It uses visual impacts that can be quantified to track resource impacts such as trail growth, trash around the entrance, litter in the cave, graffiti, speleothem damage, and the like. An example of a Cave Visual Impact Evaluation Worksheet can be found in Appendix 5–12. Using this worksheet a manager can identify which areas need to be scheduled for restoration projects or consider changes in visitor management. This could mean requiring trip leaders, reducing the number of trips entering the cave, or limit the number of persons per trip.

3. **Impact Mapping** - This is a method of mapping the impacts as seen in the cave using maps that can be shaded-in to show where impacts are occurring. As updates are conducted another color or darker shades of the same color can be used to show the incremental increase of damage over time. It can also show the results of restoration projects and the reduction of impacts. The areas of impact can be digitized and put into a GIS layer that becomes an easy to use management tool.

4. **Registers, Counters, and Cameras** - A good way to monitor visitor use in back country caves and caves that do not require permits is the use of registers. They can be placed at the entrance of caves and provide an indication of the amount of use the cave is receiving. It can also provide feedback and comments that can be of value to management.

   Another use of registers can be to monitor visitation in remote parts of a cave. More than one register can be placed in a cave. One placed near the entrance for most visitors to sign and another placed in a remote destination point. That way you can tell what percent of visitors reach the back portions of the cave and the amount of damage caused by that number of visitors. An example of a cave register is located in Appendix 5–13.

   Counters can be useful tools also. Traffic counters can be installed on the road leading to the cave to get an idea of how many vehicles are driving to the area. A more sophisticated method of in-cave counter is a monitor that logs the presence of light that strikes it. These units can be quite small and easily hidden. When downloaded they will record the date and time the sensor was activated. This can be useful when trying to determine a time frame that illegal entries may be occurring.

   Hidden cameras can also be used to monitor visitor use. The use of infrared cameras in the cave can capture unauthorized use as well as use by bats and other animals.

5. **Personal Visits** - Possibly the best visitor monitoring is to go to the cave while a group is there. If you find them in the cave it is easy to assess their skill level and tell if they are in compliance with the basic cave safety and conservation requirements. It also gives the cave manager the chance to educate the group if there appears to be a lack of understanding of the rules and provides a proactive agency presence.

C. Resource Monitoring

When considering resource monitoring you have to start somewhere. When you conduct the first inventory or analysis of conditions on any resource that becomes your baseline. Historic data and information can be entered into records and become part of a historical base. It is from that baseline data that monitoring begins. Any changes from that baseline are indications of the effectiveness of management actions. These changes may be positive or negative. Some changes may not have anything to do with management actions but a result of environmental changes or activities outside the control of the BLM.

1. **Surface Disturbance/Encroachment** - Monitoring the surface disturbance or encroachment of activities is an important aspect in protecting cave and karst environments. After all, they are integrally connected. On a landscape scale the planning system can be very useful in identifying areas to minimize, limit, or prohibit surface disturbance. By keeping informed of proposed surface actions negative impacts to caves and karst can be greatly avoided or mitigated. In the case of land use actions such as roads,

pipelines, power lines, facility sites, well pads, and the like, the NEPA process should alert the karst manager to the possible impacts and mitigations. The manager is then reliant on the known information about the extent of the karst lands they manage. The use of areal and satellite imagery is a good way to do comparison monitoring to look at long term landscape change. They can also be used as a first line defense for clearance work. However, nothing is better than going out to the site for a first-hand look.

2. **Species Monitoring** - Bats and Bugs - Having a comprehensive biological inventory conducted is a great benefit to understanding the ecosystem and biological community of a cave system. Caves are such unique environments that it is not uncommon for new species of troglobitic wildlife to be found during such inventories. Biological inventories can be conducted at any level and at any time. Simple things as recording species observations of cave crickets, spiders, bats, and other invertebrates and putting them in the cave file can be a good start. Documenting the presence of species sets base line information that can be referred to later to document changes in the biological makeup of the cave.

   When a more detailed biological inventory is necessary it should be conducted by biospeleologists with the expertise to collect and identify the various species.

3. **Water Quality** - For karst areas containing critical water resources and caves that go down to ground water level it is wise to begin a water-quality monitoring program. Initially water samples should be taken and have a basic water analysis run. That would include such things as temperature, dissolved oxygen, ph, conductivity, total dissolved solids, salt contents, and other constituents that may be relevant to the local area. In addition, other specific elements may be targeted. These may include; various hydrocarbons, arsenic, lead, and other heavy metals. Knowing what the water chemistry is will provide a baseline from which to monitor any changes that may occur due to undesirable events such as tanker spills, pipeline leaks, settling pond breaches, and any other incident that could contaminate groundwater resources.

4. **Climate** - It has become more and more apparent with the onset of White-nose Syndrome that having accurate baseline data on cave climate is a critical part of the information database. Cave temperature and humidity monitoring should be done over a period of several years using recording data loggers. There are several on the market. Both Hobo and i-button types record both temperature and humidity and the information can be downloaded and analyzed using computer applications.

   When considering where to place the data loggers they should be put in several locations a cave that would represent areas that bats and other wildlife may use. Look for areas of potential cold traps that may be suitable for hibernation and warm areas that may be used for nursery colonies. They should be placed in locations that are not readily visible to visitors to reduce potential disturbance. Monitoring locations should be put on a map of the cave to ensure recoverability and as an aid in overall resource management.

5. **Other Resource Monitoring** - It is important to document and monitor any other resources that may be fragile or susceptible to damage. This can include paleontology, archeology, critical bat roosts, or any valued resource that has the potential for disturbance.

III. RESTORATION METHODS

This section covers some of the basic and most common types of cave restoration encountered. It is not intended to address it all. There is a very good book available from the NSS entitled "Cave Conservation and Restoration" published in 2006. It is suggested here that this publication is a primary source book.

A. Graffiti Removal

This section is excerpt from the Chapter on Graffiti written by James Goodbar and Val Hildreth-Werker in the National Speleological Society book "Cave Conservation and Restoration".

In caves, graffiti can be quite old and provide evidence of historical use by early visitors. It comes in all shapes and sizes and in a variety of media. Graffiti can be drawn or written with ocher, lampblack, or spray paints. It is found scratched into soft surfaces. Arrows, words, names, dates, cartoons, and pictograph replicas are marked on cave walls with crayon, lipstick, nail polish, and permanent marking pens.

Graffiti, no matter how bad it looks is a rich part of human history. Before considering removal of any graffiti, a careful historical and cultural evaluation should be conducted. During an inventory of the cave's artifacts and features, expert archeologists and/or historians should provide consultation.

Following consultation, if the graffiti is deemed to have insignificant historical value, the cave managers may decide on documentation and removal. However, markings deemed historically or culturally significant should remain as they are and should not be removed, touched, or harmed in any way—historic signatures and historic or prehistoric cave art is easily damaged.

Some of the most common media for graffiti include incised or etched material, paint applied by hand, torch mark, candle smoked carbon, carbide soot, pencil, and spray paint. There are poorly understood chronological parameters for each. For example, spray paint is post World War II, and the carbide era is between 1900 and 1970. The same is true of prehistoric natural pigments. While photographs record content and style, field notes should thoroughly document the site as well as the media and give insight to authenticity and importance.

1. **Photograph Graffiti Before Removal** - Always photograph and thoroughly document graffiti before deciding whether to remove it. Keep in mind that evidence written in contemporary graffiti may facilitate the identification and prosecution of vandals. Use photodocumentation of recent offenses to improve cave management, enhance conservation education, or pursue legal prosecution. Photographs also provide a small measure of protection against loss of historical or cultural data through accidental removal or ignorance.

   Within the federal government, each agency has specific regulations that can be cited in the prosecution of known offenders. Generally, those regulations address the destruction of government property or the Federal Cave Resources Protection Act of 1988. Many states also have cave protection laws that prohibit making new graffiti in caves.

   Laws and regulations also provide helpful guidelines for determining when to preserve graffiti. The Archeological Resources Protection Act of 1979 sets 100 years for the protection of cultural remains. However, 50 years is generally accepted in the field of archaeology as a date signifying historical importance.

   It is always wise to seek permission from the landowner or cave manager and request assistance in determining whether it is appropriate to remove graffiti and what portions should be left on the cave walls to preserve historical or cultural data.

   Beyond laws and prosecution, consider the other consequences. If historical or cultural value is in question—no matter how vague the lingering doubts—markings can always be removed later. If removed before the value is determined, it's gone forever.

2. **Tools and Techniques** - If it is determined that contemporary graffiti should be cleaned off; the type of media indicates how difficult it will be to remove the unwanted marks from caves. Enamel spray paint seems to be the worst offender and requires extensive scrubbing, but carbide black can often be sprayed clean with water.

   Judicious application of water may help where rough rock with small cracks and declivities make it difficult for brushes to reach. Hard work, perseverance, and specialized tools are key factors to success. Delicate formations such as helictites, soda straws, and fragile gypsum formations will always present the greatest challenges of the day.

- Stiff, nylon-bristled brushes cause the least amount of damage to cave surfaces.
- Stainless steel brushes, when used with a light touch, work well for some surfaces. Be aware that any metal brush, stainless steel included, will leave black marks on some surfaces.

As stated above, nylon and stainless steel brushes are generally best for cave use. Stray bristles made of nylon or stainless steel are less offensive to cave environments than bristles made of other materials. Even with catchments and careful scanning of the restoration area, some bristles are likely to escape and remain in the cave.

- Brass brushes leave a fine metal sheen on formations and rock.
- Steel wire bristles will break off and oxidize (rust), discoloring the surrounding cave surfaces. Deteriorating steel adds ferric hydroxide and ferric oxide to the cave ecosystem.
- Natural fiber brushes leave bristles behind that can provide nutrients for molds, mildews, and fungi. Natural fibers may disrupt a cave's ecological balance, providing new food sources for biota and microbiota.

3. **Rotary Brushes, Grinding, and Sanding** - Rotary brushes on electric drills are an option, but they have a tendency to scatter paint flakes and bristles over a large area. Rotary brushing or sanding can remove a lot of rock or flowstone in a very short time and this method should only be used if deemed appropriate. For this technique, assign a careful, gentle operator—someone with a good light source, exceptional close-up vision, and patient attention to detail.

   Always prepare with adequate catchment procedures.

   Scrub gently. In scrubbing cave surfaces, be careful to avoid removing layers of mineral. The layers uncovered may not be the same color as the layers removed. Scrubbing away mineral layers may result in a well-defined clean area in the shape of the letters just removed.

4. **Water Sprayers** - When it is appropriate to remove contemporary graffiti from cave walls, water can help loosen the media and clear paint flecks from the scrubbing area. Clean, chlorine-free water is the best solution. It is usually not detrimental to cave biota and does not harm most speleothems. It is safe for human use, inexpensive, and readily available. Water alone generally cleans off arrows and markings made with the lampblack from carbide lanterns.

   Only new, clean products should be used in caves. Always avoid introducing household cleaning chemicals, herbicides, pesticides, or other human-manufactured chemicals into the cave environment.

   a) **Hand-held Spray Bottles** - Hand-held squirt bottles are easy to purchase, use, and carry into the cave. They are easily refilled. Adjustable nozzles can be used to spray wide areas or shoot a stream to loosen and remove debris such as lampblack and flakes of paint.

   b) **Garden Sprayers** - Garden sprayers, in a variety of sizes up to five-gallons, are useful tools for some graffiti projects. They commonly include a pump for creating pressure within the container. The resulting water stream is stronger and more continuous than the spray produced from a hand-held squirt bottle. Again, designate new garden sprayers for cave restoration work (used ones may contain insecticides or other chemicals that can wipe out cave communities). Sprayers may also be used to clean mud from speleothems and trails.

   c) **Bladder Bags** - A close cousin to the garden sprayer is the bladder bag, or backpack pump used for firefighting. The bladder bag consists of a 5-gallon rubberized canvas bag with shoulder straps. Water is squirted through a hand-held trombone pump attached to the bottom of the bag. Bladder bags are used where moderate pressures and high volumes are required.

d) **Avoid Delicate Speleothems** - Be careful when using high-pressure water devices in areas of delicate speleothems. The pressure combined with a larger volume of water can easily break or damage fragile cave formations.

e) **Gravity-Fed Water Delivery Systems** – Gravity-fed systems are often efficient, but first consult local cave scientists and thoughtfully evaluate the ecosystem before introducing significant quantities of water into a cave system. Runoff water should always be controlled. (See cautions described in the restoration runoff section in this chapter, below.) If deemed appropriate, a new garden hose with a trigger nozzle is run from a water supply at the entrance. Depending on the gradient, a substantial head of water is produced and special caution must be exercised to avoid damaging delicate areas. Check that all couplings and gaskets are in good condition to prevent leakage.

f) **Protect Invertebrates and Biofilms** - While it is efficient to use large quantities of high-pressure water to help remove graffiti, there are drawbacks. Cave habitats may become flooded—plus, pressurized spray can harm invertebrates and blast away microbiota. Thin biofilms of microscopic organisms living in moist or wet areas should not be sprayed or scrubbed. Pressure blasting can damage communities of microorganisms—microflora and microfauna are often impossible to see with the naked eye.

5. **Where Should You Get Water** - For cave graffiti projects as well as other cleaning projects, it is generally acceptable to use clean, fresh water with no chlorine or commercial chemicals. For some cave systems, distilled water may be an option, if minimal amounts are applied with short contact duration. No single recommendation is best for all caves. In caves with active streams and annual flooding, water from the cave may be the best choice for graffiti cleaning.

   However, be careful not to use water from isolated cave pools that are slowly refilled over geologic time. Carefully avoid cross-contamination within a cave—transporting cave water from an isolated passage to a different chamber may destroy local indigenous microbial populations.

   Consult with scientists, cave owners, land managers, and knowledgeable cavers before cleaning, and select the least damaging water source for any cave restoration project.

6. **Always Catch Restoration Runoff Water** - Always collect the runoff water from graffiti efforts, regardless of where the project is located in the cave. Never allow runoff to contaminate cave pools, streams, or water sources. Use large sponges, lint-free towels, environmental remediation "pigs," or shop-vacuums to soak up or contain restoration water. Vacuuming devices must be used cautiously to assure that natural loose material and biota is not sucked up.

   When restoration water is scarce, runoff is sometimes strained and filtered back into a bucket for reuse. However, be careful—used water may contain flecks of paint or lampblack that should not be left in the cave. It can be filtered and reused if all contaminates are removed. Runoff water may also contain lint and debris that should not be washed elsewhere in the cave. Be very cautious about deciding to introduce large quantities of water with hoses or pressure washers. The runoff is difficult to contain and pressurized methods generally cause graffiti byproducts, lint, and loose sediments to be re-deposited elsewhere.

7. **Weigh the Ecological Costs** - Scrubbing layer upon layer of contemporary graffiti made by cave vandals is frustrating, irritating work. Understandably, innovative volunteers want to speed up the process with mechanical devices. However, assist from powered tools is often inappropriate for cave habitats.

   On the other hand, a few caves that are heavily trafficked party sites are also playpens for graffiti vandals. The natural ecosystems and surface textures in these caves have already been severely altered. Often, the damage has occurred over many decades. Carefully evaluate the environmental costs before embarking on projects that will significantly change cave surfaces and diminish populations of the current biological communities.

8. **Avoid Using Heat on Cave Walls** - Application of direct heat inside caves is not recommended. Heat damages rock surfaces and limestone—the rock heats up and spalls off along with the paint. Heat should never be used on gypsum or speleothems. Direct application of heat to gypsum drives off water. Direct heat changes transparent selenite to white powder and destroys the crystals. Though it seems an easy solution, propane torches and other surface heating devices are not appropriate for cave walls and toxic fumes may harm cave-dwelling communities.

9. **Avoid Commercial Chemicals in Caves** - Historically, cavers have tried everything from oven cleaners, hot solvents, and acids, to citrus-based cleaners, soybean products, and biodegradable magic pastes. Some products will remove paint, but should not be used on cave walls—commercial chemicals and acids damage cave life as well as the people applying them. The fumes are harmful to humans and wildlife in the enclosed spaces of caves. Natural airflow carries toxins throughout the cave, disrupting or harming bat colonies and other fauna.

   Some products that claim to be environmentally safe simply do not work and labels often overstate their benefits. When analyzed in the laboratory, products commonly do not live up to their advertised claims of environmentally safe content. Even if a product is truly biodegradable, it will probably provide an unusual food source for biota that depends on the cave's natural ecosystem.

   It is always best to avoid changing the natural processes that sustain life within caves. Some forms of cave life are able to recolonize a restored cave, but not all. (For example, certain microbes may not exist beyond the pool where they currently live. If the ecosystem of that pool is destroyed by chemical contamination, that colony of organisms may be gone forever.) Usually, the safest substance to use is water.

10. **Camouflaging Cave Graffiti** - When all else fails, cover it up. Small amounts of dirt or mud from the cave floor will generally blend with the color of a cave wall if there are naturally occurring muddy surfaces. This technique can be used as a temporary measure until more volunteer time is found or a better method is developed. A lightly applied natural poultice sometimes loosens the media for easier removal during the next restoration effort.

    Camouflaging techniques are not recommended for speleothems. Dirt or mud will not stay on active formations. The crystalline micropores will become clogged. Camouflaging soil is almost always a different color than the speleothem and generally looks as bad as the graffiti.

B. Cleaning Formations

Cleaning speleothems can be a rewarding and fun endeavor. There is something magical about squirting off layers of old mud to reveal some beautiful formations below. The same goes for sweeping of lots of dust and debris to uncover a set of rim stone dams. There are some things to consider, of course. Many of the concepts brought up in the graffiti section hold true with formation cleaning.

The water sources used in cleaning should follow the same guidelines as described in the Graffiti Removal section, likewise with the use of water spray devises and brushes. The nature of the area being cleaned will dictate what type of sprayer and brush should be used. In some locations a garden sprayer and stiff nylon bristle brush may be used. In other locations a small hand sprayer and soft bristled toothbrush may be the tool of choice.

It is always a good idea to capture the dirty runoff water towels or other similar absorbent material. This can be squeezed into a 5-gallon bucket and allowed to settle. The clean water may then be siphoned off the top and reused and the mud can be disposed of in an appropriate place.

Once an area has been cleaned it should be flagged off or proper trails marked around it to avoid future problems.

C. Repairing Broken Formations

There are a number of questions that should be asked before deciding to repair broken formations:

1. **Cause** - Is it a human caused break or is it a natural break? If it can be determined that it is a natural break then many researchers and managers believe that it should not be attempted.

2. **Safety** - Is it safe or could it present safety concerns to the workers/volunteers trying to make the repair. This may be in terms of the location or the size and circumstances of the speleothem being repaired. Will it take particular rope work to belay the speleothem or the worker? Will there be any scaffolding needed to support either?

3. **Location** - Is it in a location where it is likely to be broken again?

4. **Materials** - Are the right repair materials available and on hand?

There are a few types of epoxy that have shown good results underground. One of them used successfully is over the years is Epon 828. It is used with either of two different hardeners, Versamid is used for dry environments and Epi-cure 3234 should be used in wet environments. Follow manufacturers' recommendations for mixing ratios.

Depending on the size of the speleothems being repaired, it is very important to first make sure the pieces fit together. If they are small they may not require a dowel pin to hold them and can be fitted together using enough epoxy to cement them without too much over flow. Larger formations may require holes to be drilled into the matching ends and fitted with a stainless steel pin in the center of the formation. The pin is cemented in and the pieces are rejoined. This continues until all the pieces are back in place. Sometimes it is necessary to devise a way to hold a formation in place until the epoxy is dry.

There are many tips, techniques, and details to formation repair discussed in the NSS Cave Conservation and Restoration book. It is quite worth the expenditure for the amount of practical information contained there.

IV. CAVE/KARST SURVEYS

Maps of caves and karst areas are critical in being able to manage the resource. You can't manage something if you don't know where it is and what may affect it.

A good way to start mapping out the cave and karst areas of your area is to look at geology maps for those rock types that may contain caves such as limestone, dolomite, gypsum, and lava flows. That may be a good start but there are other types of cave that may form in other rock types. Knowing where your primary caves and karst areas are is critical in being able to manage and plan for your fragile resources.

Cave maps are one of the most important tools a cave manager can have. A good cave map can provide a manager with critical information about the cave.

Being able to see where cave lies in relationship to the surface, where the sensitive areas within the cave are, trouble spots, and potential rescue locations gives the manager a good grasp on what type of protection the cave and the visitor needs.

A. Methods and Standards

Modern day cave surveys can produce highly accurate maps when conducted properly. New equipment, surveying techniques, and cartographic software have made it possible to quickly reduce survey data and produce high quality maps. Cave survey maps can be loaded into GIS layers and viewed over other layers to show where potential problems may be. The applications of GIS can be quite extensive. An example of survey standards can be found in Appendix 5–14.

B. Data Storage

When possible it is best for the original survey data/notes to be kept by the BLM. The BLM can scan copies and send them to the surveyors to use in drafting the map. In this way the agency has accurate records of the resources they manage and can use that data to produce maps and develop management strategies.

V. RESEARCH PROPOSALS

One of the best things a manager can have is someone who wants to conduct research on their resources. If approached by a potential researcher one of the first questions to ask is what is the credibility of the researcher and with whom are they affiliated. The second question to ask is whether the research will benefit the BLM and the management of the cave or karst program. Proposals should include at a minimum:

- Who (what group, institute, or organization) will be conducting the activity
- A detailed description of the activity proposed
- Purpose, Justification, Significance of the research/proposal
- Duration of the project
- If any collecting will be necessary; what is proposed to be collected, need for collection, where collections will take place, quantities to be collected, what research will be done on the collected material, disposition or storage location of the collected materials.
- What benefit will their project be to the public or to cave/karst resources on BLM lands
- What the BLM will receive in the form of reports etc.
- What time frame will these receivables be given to the BLM

Some research proposals may require the collection of biological, mineral, or other samples. If this is part of a research proposal it is essential that a separate collecting permit be issued. The collecting permit (example Appendix 5–15) ensures the proponent is aware and agrees to the special conditions that are attached to the authorization. It is issued in conjunction with the research proposal approval and the issuance of a cave permit (if necessary). An example of a research proposal outline is in Appendix 5–16.

Proposals should be reviewed by individuals with the experience and expertise in the field the proposal is seeking to work in. It is best to have two or three reviewers evaluate the proposal. Outside assistance from academic or the scientific community may be requested to help with the evaluation. Follow-up calls to the proponent may be necessary to clarify any questions about the proposal. The reviewers can then make their recommendations to line management to either accept, modify, or reject the proposal along with their rationale. This process should be completed in a reasonable time frame so the proponent can plan accordingly. Four to six weeks should be sufficient in most cases.

Monitoring and compliance are important aspects to follow-up when authorizing research or special project. Ensuring that the time frames for reports and deliverables are being kept up and the minimal damage or disturbance to the cave and its resources is in compliance with the terms of the authorization is critical. This ensures the BLM receives the information it needs to justify the authorization of the project and provides verification that the project is credible. It also builds the BLM as a credible land management agency. When possible, a BLM employee should accompany the collecting party to help in the selection of the specimens and/or the area.

VI. CAVE SAFETY STANDARDS

Visitor and employee safety is the foremost objective of the Bureau of Land Management's (BLM) cave management program. The purpose of the BLM' Cave Safety Standards is to establish a course of action that can be followed to assure minimal risk to people (both BLM employees and the general public) entering caves on public lands. These standards consist of Cave Safety Guidelines, Search and Rescue (SAR) Pre-Planning, and Risk Assessment Check List (previously the Job Hazard Analysis) (Appendix 5–18).

Most cave environments are safe for human use. A safe caving experience depends on sound decisions and staying within abilities. As with any recreation activity, there may be associated risks when entering caves.

Ill-prepared or uninformed personnel face the greatest risk in cave entry. Most cave accidents are avoidable with prior planning, training, and the use of the proper equipment. BLM's obligation is to educate cave entrants to the extent possible so they can make informed decisions about their own welfare. Public information and education efforts will continue within funding and manpower limits.

Frequent cave entrants are usually informed and aware of most of the inherent risks that may exist in caving activities. The BLM entered into a Memorandum of Understanding (BLM-MOU-WO 250–2012) with the National Speleological Society (NSS) for assistance with managing cave resources. This MOU provides for cooperation between the BLM and the NSS local chapters for the cooperative development of cave safety plans including standards for equipment, experience, and rescue procedures. The NSS's affiliated Grottos or local caving groups associated with the NSS should be contacted when information is needed on the locations and risks associated with caves in your area. The NSS has Grottos in 47 States; a list of the Grottos can be obtained from the NSS. The NSS National Office may be reached by phone at 205–852–1300 or via email at *nss@caves.org*. The web site address is *www.caves.org*. The local caving community can assist the BLM with completing cave safety analysis and by making recommendations for personal protective measures for cave entry.

A. Cave Safety Standards

The following guidelines will serve as a recommended course of action for BLM employees:

1. The local caving community (NSS affiliated grotto) should be contacted to assist the BLM in conducting a uniform safety analysis for each cave under BLM administration. The results of this analysis should be utilized to implement visitor awareness by informing all cave users (BLM and general public) prior to entry into the cave.

The BLM will take the necessary steps to inform and educate cave visitors of the steps necessary for a safe trip. These steps will include a list of known safety risks to inform the visitor of cave use authorizations, cave use registration stations, and cave entry signs. Some caves may require additional monitoring to reevaluate conditions.

2. A Cave Search and Rescue Workshop should be attended (or hosted by offering facilities or organizational assistance) by BLM cave specialists and other personnel responsible for cave use administration. Primarily the National Cave Rescue Commission, the National Outdoor Leadership School, National Park Service, and County or State Search and Rescue Groups sponsor these Cave Search and Rescue Workshops. These workshops, lasting from one to eight days in length, are intended to increase rescue awareness and improve coordination between rescue personnel, organizations, and agencies.

3. Training should be provided to BLM cave specialists in climbing techniques required for the safe use of caves. BLM should take an active role by co-sponsoring and assisting in such training. Training will consist of above-ground orientation and underground experience with a qualified cave leader. Employee technical skill training and experience are essential to aid in the prevention of injures and enable employees to better judge the skills of visitors.

4. Employees will conduct underground work in groups of three or more, never alone. This also applies to volunteers.

5. Employees will lead underground operations only after receiving adequate training and having sufficient experience in the cave to be visited.

6. Training should be provided in relevant winter, desert, or other local climatic survival techniques for employees with cave management duties. Basic survival equipment will be made available to cave specialists.

7. Due to the twilight zone of caves being utilized by wide variety of mammals, reptiles, and insects, caution should be used when entering or exiting the cave to avoid potential risk. BLM employees will be trained to avoid this risk and the proper actions to take should an employee be stung or bitten. Proper medications and first aid supplies will be made available to employees. Visitors will be cautioned when entering these areas as a part of the permitting process.

8. BLM cave specialists will receive Red Cross Basic First Aid Training or a Wilderness first aid training course as soon as possible. This can be part of the annual CPR/First Aid Training offered to all BLM employees.

9. Caving and cave rescues take place in a very fragile environment. All possible care should be taken to assure that both cavers and cave rescuers impact this environment as little as possible. The Leave-No-Trace philosophy should be adhered to. Whenever possible, cave specialists are to use established trails, are not to touch formations or disturb Cultural or paleontological resources, and should carry out all wastes and trash. This includes all human waste. The disturbance or discovery of cultural or paleontological resources should be reported immediately to the BLM Field Office Manager.

10. Light sources should be helmet mounted in order to leave the hands free for negotiating the cave. It is recommended that the primary and first back-up light source be helmet mounted. The third light source is usually a flashlight on a lanyard. The lanyard should go over the shoulder and under the arm rather than around the neck.

11. In all cases of entry into caves that are heavily utilized by bats, rodents, or other animals, personnel will wear protective clothing to avoid possible health risks introduced by the animal droppings. Personnel will avoid these areas when possible.

12. When negotiating uneven or slippery cave passages, a belay should be used. Training in the proper procedure for belaying should be practiced before the trip with the device, which will be used on the trip.

13. A minimal number of caves may have atmospheric conditions that are not favorable for entry. Cave atmospheres and other associated hazards will be evaluated as part of the Risk Assessment process and handled on a case-by-case basis. These caves will be posted at the entrance, and a log kept at the area office of the inherent risks present at the time of the evaluation of the cave. A BLM employee will conduct a periodic reevaluation as applicable or prior to entry.

14. The Boy Scouts of America have a specific program and procedures for caving. Scouts are actually required to go through a certification process with signed documents in place prior to allowing the youth to go caving. You should verify with the Troop Leader that this certification process has taken place prior to authorizing Boy Scout's use of caves.

B. Search and Rescue (SAR) Procedures/Pre-Planning

This section offers simple strategies for cave search and rescue planning. A cave SAR Pre-Plan consists of a recommended course of action in the event of a caving emergency and does not need to be lengthy. Having a concise and brief cave search and rescue pre-plan can save critical time during an emergency.

While the BLM will normally be in a supportive role in cave SAR operations, it should take the lead for expediency in life or death situations or when non-Bureau SAR programs are not capable of providing cave rescue service. The Bureau should determine the sufficiency and availability of existing cave SAR programs and assist and support local authorities and cooperate with qualified cave organizations. To expedite SAR response, partnership agreements between the BLM and responsible authorities should be developed. Separately, the Bureau should take whatever action is necessary if a SAR action involves a BLM employee.

Counties with infrequent cave SAR missions often send untrained cave rescuers to conduct cave rescues. Local training is often the most important part of a cave rescue pre-plan, because it associates the SAR team with the people who are lifelong cavers.

Each BLM field office with cave resources should have a Cave Search and Rescue Pre-plan as a part of, or addendum to, a Cave Management Plan or the District's Search and Rescue Plan. The purpose of having a Cave SAR Pre-Plan in place is to save time in the event of an emergency. Personnel changes reinforce the need for a written, readily available Cave Search and Rescue Pre-Plan.

Detailed guidance on the recommended formats for cave search and rescue pre-Plans, documentation sheets for overdue, lost or injured cavers, and a cave search team debriefing report is provided on the following 10 pages. This guidance should be used as a reference source when preparing cave search and rescue preplans for your cave areas.

Conclusion

Risk management is the primary factor of consideration in the administration of wild cave resources for public use. While the BLM cannot make all caves completely safe for all users, a proactive cave safety policy will complement the Bureau's cave management program and minimize cave accidents. Standardizing caving equipment, techniques, procedures, and training will increase cave safety. Implementing the cave safety standards discussed above can prevent most accidents; however, the ultimate responsibility for the prevention of cave accidents rests with the cave user.

The BLM is thankful to the National Cave Rescue Commission, the National Outdoor Leadership School, and the National Speleological Society for contributing towards the development of these cave safety standards.

C. Search and Rescue (SAR) Pre-Plans for Caves

Importance

Pre-plans are especially important in areas with infrequent search and rescue incidents. It is important that any pre-plan is simple or it won't be used in a time of crisis. It is also important that key people (cave specialists, managers, and dispatchers) know how to quickly access the written pre-plan.

Pre-plans organize personnel and equipment for urgent incidents. They provide guidance through the initial response. For extended incidents, they are replaced by a plan drawn up during the first operational shift.

Searches and rescues are different types of urgent events. Both are emergencies since human life is at risk. The pre-plan is not supposed to provide step-by-step instructions for all personnel. The pre-plan is a document from the BLM resource area or district manager to his/her staff that uses the Incident Command System (ICS) to provide clear leadership and organizational guidelines in urgent situations. The document should not restate what ICS is; it is a simple document that helps organize cave rescues. Fremont County,

Wyoming, uses a one page pre-plan with four pages of appendices. The Worland Wyoming BLM District uses a 20 page pre-plan that lists all local resources, item by item, and provides much more specific guidance. The pre-plan should help the BLM field office move fluidly in a time of urgency. There are two very different types of pre-plans, general and specific.

1. **Contents of Cave Rescue Pre-Plans** - Cave specific SAR pre-plans, which are specific to one cave.

    a) **Cave Description** - Describes the cave including temperature, humidity, flood potential, and hazards. Identify specific locations in the cave where obstacles exist that require special rope work (lift or lowering systems), what kind of system is needed, and how much rope, equipment, and personnel are needed for that location. Identify other special needs or obstacles such as tight restrictions, narrow or sharply twisting passage, water passages, or special communications needs.

    b) **Access** - GPS coordinates need to be available. Descriptions how to get to the cave in simple terms so a deputy or cave specialist can go see if anyone's there. GPS coordinates of the closest possible landing zone in the event a helicopter needs to be brought in to airlift the patient to a medical facility.

    c) **Caver Parking Area** - Describes how to get to the most likely spot to find an overdue caver's vehicle. It also helps rescuers find the cave in the middle of the night.

    d) **Special Equipment** - Includes specialized gear needed for certain passages.

2. **General** - Cave SAR pre-plans describe the BLM field office's response to any cave incident. They don't contain specific cave information, but should have a simple referencing system so the general pre-plan steers the responders to documents or people with specific information. The components to consider in a general pre-plan include:

    a) **Search Initial Response Plan** - Informs the Bureau manager or cave specialist who initially takes charge (Incident Commander) how to respond and who to initially involve. This should only be about a page long. It should be the first part of the pre-plan since it describes the strategy BLM will employ.

    b) **Rescue Initial Response Plan** - Similar to the above, but specific to rescues.

    c) **Dispatcher's Cave SAR "Cheat Sheet"** - Questions to ask the reporting party.

    d) **Cave Rescue Personnel Lists** - Home phone numbers.

        i) Internal

        ii) Local

        iii) State and Regional (have a copy of the National Speleological (NSS) Member's Manual available)

    e) **Cave Rescue Logistics**

        i) Internal

        ii) Local (including County and State Emergency Management Coordinator)

        iii) Regional (identify the Regional Cave Rescue Coordinator by calling the NSS)

    f) **Medical Pre-Plan**

        i) List the local medics who have cave training/expertise.

ii) Identify the nearest medical and trauma centers and if they have medivac helicopter landing pads.

g) **Forms**

i) Overdue caver questionnaire (Appendix 5–19)

ii) Lost caver questionnaire (Appendix 5–20)

iii) Injured caver questionnaire (Appendix 5–21)

iv) Search Team debriefing sheet (maze caves need this more than others) (Appendix 5–22)

v) Master copies of cave-specific forms

h) **References** - These could be kept in your Emergency Operations Center.

i) Manual of U.S. Cave Rescue Techniques, by Steve Hudson

ii) Latest copy of the NSS Members' Manual

iii) Next latest copy of the NSS Members' Manual (format alternates annually)

iv) Any search text (e.g., NASAR Field Commander's Notebook for SAR)

v) ICS Plans Book (contains master ICS forms to be photocopied)

vi) Appropriate phone books for local area and agencies

3. **Distribution of the Written Pre-Plan** - The pre-plan should be kept in the dispatcher's notebook. It should also be posted on the wall in your Emergency Operations Center. The Emergency Operations Center is often either a room in the Sheriff's Office with a phone and a radio or the BLM field office.

D. Generic Cave Search Pre-Plan

A search is an emergency. Search management involves a sequence of steps that are started in order, with each step progressing until the situation is resolved.

The search management sequence is:

1. **Pre-Plan** - Be prepared. Know the hazards and resources.

2. **Interview** - Information must be gathered from first notice. The more information, the more focused the effort can be. The investigation scales up as the search progresses and more search areas are ruled out.

3. **Call Out** - Trained help should be enlisted. At this stage, it is time to evaluate the urgency of the situation. This will determine the size and type of response. It is critical that in-cave tasks are dealt with by experienced cavers who can make the judgment calls needed underground.

4. **Establish the Search Area** - In a cave incident, we may consider the entire cave at the early stages, but should then establish segments within the cave and assign them priority or rank. We must not ignore the fact that the subjects may no longer be in the cave or that they may be in a portion of the cave not on the map.

5. **Confinement and Attraction** - Once you have established the search area, it is vital that you know if the subject leaves the search area. In a cave situation it is also vital that you know if the subject moves from

one segment to another. Guard the entrance(s) and maintain an accurate log of who entered and who left. Place lights with notes and other attraction devices at key cave intersections so wandering searchees will stay there.

6. **Hasty Search** - To begin active search, the best action is to quickly check out the most likely places first. Speed is the primary objective here. Check the obvious, look for clues, and report conditions.

7. **Wide Search** - The objective here is efficiency, not pure speed nor absolute thoroughness. Search the passages in order of priority segments. This allows for search of the maximum amount of cave with the cavers on the scene in the fastest time possible. The process can be repeated for increased coverage if needed.

8. **Grid Search** - As a last resort before suspending the mission, a grid search can be conducted. Grid searching is slow and highly labor intensive, and it is important that teams mark the territory covered in some way. You may have to mount a cleanup trip later to remove all of the notes and flagging. In a complex cave system this process could take a huge number of people an incredible amount of time.

9. **Rescue/Suspension** - Whatever the method used, the goal is to find the person or determine that they are not within the search area. If found, the exercise becomes a rescue and/or recovery operation. The options if they are not located are to expand the search area (e.g., to some other cave or some part of the cave we do not know) or to simply scale down the operation. The object is not to quit, but to scale back. The decision to scale back is a tough management decision and should be carefully documented.

10. **Critique** - Identify the problem areas and the efficiencies—what worked and what did not work. How can the cave search be improved the next time?

E. Training

Internal training begins with familiarization with the written pre-plan by dispatchers and BLM staff. A next step is having the BLM staff read appropriate parts of Cave Rescue Techniques. The staff should be comfortable with the first four chapters and aware of the rest of the book as reference material. Finally, a simple mock cave rescue by the local SAR team may be the most valuable preparation.

External training can be done at your site or at national seminars. National Cave Rescue Commission (NCRC) runs annual weeklong cave rescue seminars and currently offers four levels of training (4 weeks total). NCRC also runs many weekend workshops. The best use of staff time may be to have an NCRC instructor offer a short workshop on your site. Inviting other local agencies to participate will help organizations coordinate and cross-train better. Other external training includes ICS training and especially, Managing the Search Function (MSF), a 40-hour NASAR course, or Managing the Search Operation (MSO), with a similar curriculum.

VII. PARTNERSHIPS AND AGREEMENTS

Assistance agreements can be efficient, effective management tools in forming partnerships between agencies and caving groups and for accomplishing cave projects. These documents can be sophisticated volunteer agreements that establish affiliations between special interest groups or they can be agreements between agencies for the benefit of public resources. As specialized legal instruments, assistance agreements address specific tasks or problems. Agreements may involve the exchange of monies or provide for the mutual acceptance of services without the exchange of money. Resource managers needs to know what type of agreements are available, how to implement them, and when to use these documents. No matter what kind of assistance agreement is used, it is important for all parties to clearly state the objectives.

A. Authorities

Two of the most common authorities used in cave agreements are The Federal Land Policy and Management Act of 1976, Section 307(b), 43 U.S.C. 1737(b) and The Federal Cave Resources Protection Act of 1988, Sec 4(b) (3), 16 U.S.C. 4303(b) (3). These can be used in almost every circumstance.

B. National Agreements

There are two national agreements in place that can be used to further cooperation and collaboration in cave and karst management. The first is an Interagency Agreement among the Bureau of Land Management, the National Parks Service, the US Geological Survey, the US Fish and Wildlife Service, and the US Forest Service. This agreement identifies how the agencies will work together in the areas of Protection of Sensitive Information, Environmental Education, Training, Information Pooling and Transfer, Research, Regional Agreements, Publications, the Protection of Cave and Karst Resources on Adjacent Federal Lands and Minerals, and our cooperation in using the National Environmental Policy Act. It also describes the need for the Agreement and the cave and karst resources management policies for each agency. This agreement has a 5-year term and can be reauthorized at that time. It has been in place since 2003. (Appendix 5–23)

The second national level agreement the BLM has specifically dealing with cave and karst resources is a Memorandum of Understanding (MOU) with the National Speleological Society and the Cave Research Foundation (CRF), (Appendix 5–24). It also has a five-year renewable term and has been in place since 1984. The agreement sets broad provisions for cooperation with the groups and establishes national collaboration. It covers Access, Confidentiality, Research, Activity Reports, Acknowledgements, and Additional Agreements (CMA, Volunteer).

C. Local Agreements

In times of tight budgets and minimal personnel, partnerships with various user groups can make a critical difference in accomplishing cave and karst resource management goals. There are several types of local agreements, some involving funding and some without funding. They are discussed below. Additional information may be found in Bureau of Land Management Manual 1511 addressing assistance agreements.

D. Cost Sharing and Cooperative Agreements

There are two basic kinds of assistance agreements in which there is a transfer of money, property, or anything of value. They are the cost sharing agreement and the cooperative agreement. Cost sharing agreements are legal instruments used to reflect a relationship between the federal government and a state or local government or other recipient whenever the principal purpose of the agreement is the transfer of money or other valuables to the recipient in order to accomplish a public purpose authorized by federal statute.

E. Cost Sharing Challenge Grants and Challenge Agreements

Categories of cost sharing agreements are the challenge grant and the challenge agreement. The challenge grant is used in cases where the federal government is not substantially involved, and the challenge agreement is used where substantial involvement is anticipated between the federal government and the recipient during performance of the contemplated activity.

Substantial involvement occurs in situations where the terms of the agreement indicate that the recipient, during performance of the contemplated activity, can expect federal agency collaboration or participation in the management of the project.

These two types of agreements promote cost sharing projects by requiring the recipient to obtain or provide additional funding from nonfederal sources at a mutually agreed upon sharing ratio. The authority by which federal agencies can enter into these types of agreements is the Federal Grant and Cooperative Agreement Act of 1977 (PL 95 224), as amended by PL 97 258 (31 USC Chapter 63, 6301 6308). (More detailed

procedures for processing these agreements can be found in the Office of Management and Budget Circular A-110.)

F. Contract or Cost Share

Cost-sharing agreements do not require competitive procedures in order to award them. However, these agreements are not contracts and should not be viewed as a sole source contract as a way to circumvent the procurement process. If a more binding commitment is needed to ensure completion of the project and to establish more stringent remedies if an action is not performed, then use a contract.

A cost sharing agreement might be used if a university pays the salary of one of their research professors to conduct biological studies in a specified area and manner and the agency provides the necessary room, board, transportation, or other appropriate funding. The amount of agency involvement would determine if the cost sharing agreement is a challenge grant or a challenge agreement.

G. Cooperative Agreement

Cooperative agreements are similar to challenge agreements with one important exception. Cooperative agreements do not require the recipient to obtain additional funding from a nonfederal source. For example, a cooperative agreement may be used to provide funds to a caving organization for the assistance they provide in inventorying, mapping, and preparing files of caves located in a specified area.

H. Developing an Assistance Agreement

Generally, Congress appropriates money each fiscal year for cost sharing agreements. Before entering into cost sharing agreements, monies must be made available to the agencies for this purpose. The development of an assistance agreement is quite simple. There are only three parts: 1) purpose, 2) authority, and 3) duties and responsibilities.

1. **Purpose** - The purpose section should briefly describe the objectives of the agreement including any special emphasis or focus. If necessary, a list of objectives can be developed to more clearly outline the purpose.

2. **Legislative Authority** - The legislative authority for entering into an assistance agreement with a federal agency is cited on in the authority section on agreement documents. There are several different authorities that authorize the use of assistance agreements. These authorities may be laws or executive orders and may vary depending upon the type of project entered into.

   Always confirm the enabling legislation for each federal agency authorizing entry into assistance agreements. Listed here are authorities that may be appropriate.

   a) Probably the single most important enabling legislation that allows the use of assistance agreements is the **Federal Grant and Cooperative Agreement Act**. This Act authorizes three types of instruments: contracts, cooperative agreements, and grants.

   b) **Fish and Wildlife Conservation and Water Resources Development Coordination Act**, as amended under PL 85–624, 16 USC 661.

   c) **Federal Water Project Recreation Act**, as amended under PL 89–72.

   d) **Wild and Scenic Rivers Act**, as amended under PL 90–542, 16 US 1282.

   e) **National Trails System Act**, as amended under PL 90 543, 16 USC 1246(h).

   f) **Endangered Species Act of 1973**, as amended under 16 USC 1531.

3. **Duties and Responsibilities** - The duties and responsibilities section in agreement documents should clearly state the activities and products required of the cooperators and the agency.

I. Cooperative Management Agreement

A useful assistance agreement in which no funds are exchanged is the Cooperative Management Agreement (CMA). In most cases this type of agreement is tiered off of a broader Memorandum of Understanding. The terms of the CMA should be written out in sufficient detail for all parties to clearly understand what is expected. Documents should outline the mutually agreed upon plan of action between the agency and the cooperators and identify the responsibilities and performance standards that apply to each of the participants. An example of a CMA is given in appendix 5–26.

These agreements can be more flexible and outline broader areas of cooperation and responsibilities. They can also incorporate a Group Volunteer Service Agreement. This agreement can remain in effect for a period of five years until the agreement needs to be reauthorized. When an authorized BLM volunteer project is conducted the participants only need to sign a participants list and not go through the additional paperwork of the Volunteer Service Agreement. This simplifies and expedites the use of volunteers.

VIII. LIABILITY

Nothing is without risk. Not even getting out of bed in the morning. When it comes to caving the potential liabilities may seem to increase. However, there are ways to lower our liability, increase the safety and understanding of the cave visitor, and increase the comfort level of management when it comes to BLM employees and visitors entering caves. As the managers/owners of public land the possibility of being sued for wrongful death or injury due to negligence is always there, but it can be minimal with the practice of a few easy techniques.

If a lawsuit is filed against the BLM it will be as a tort claim. This is loosely defined as a civil wrong, arising from a breach of duty or negligence, for which the law will provide a remedy.

Legal negligence is seen as the failure to use reasonable measures to avoid causing injury to someone to whom a duty of reasonable care is owed. To find a person or entity (agency) negligent the "Reasonable Man" clause applied. This means, what would a reasonable man do given the circumstances? If the agency has a higher understanding of the situation or potential risks then the level of their action will be expected to conform to the level of their understanding or knowledge. As the land manager/owner, the BLM has a duty of care for the visitor to the extent they know of a given risk.

There are certain duties owed to a visitor visiting public lands and as the managers of that land the BLM has the responsibility to act upon any known risks. The legal status of the visitor on land defined the minimum duty owed by the agency to that person. Persons coming onto the land are placed in one of three categories.

A. Trespasser Category

The first category is that of the trespasser. That would be any visitor to public lands that does not have to have a permit for their activities. Of course, on public lands they would not technically be trespassers but would be given the same legal status as a trespasser on private lands. The duty owed to a trespasser is simply the duty not to willfully injure them. This means you cannot set up traps at the entrance of caves that could injure someone entering the cave. There is no duty to warn the trespasser of dangerous conditions existing on the land and there is no duty to modify the land in order to make it safe for trespassers. This being said, if there are known risks in a cave that is frequently used and there is an established trail going to it, then the BLM should post a notice about the potential risk at the entrance, such as "Cave Subject To Flash Flooding".

B. Permitee Category

The second category of persons entering onto land is that of the permitee. A permitee enters land with permission of the owner but not for benefit of the owner. This would be the case if a permit were issued for

entry into a cave. There is a duty to warn permitees of known dangers in the cave. However, technically there is no duty on the part of the agency to inspect the land and discover unknown dangers in order to warn them and there is no duty on the part of the agency to make any changes to the cave to put it in safe condition for the benefit of the visitor. This does not mean that failure to conduct proper inventories of the cave resources and risks would be a defensible excuse.

To control or eliminate the potential for liability it is imperative that the agency knows about its resources. Therefore, it is important for the field offices to know about the caves in their jurisdiction and conduct surveys and inventories of those resources. Part of conducting the inventories is to identify any potential risks such as low ceilings and crawlways, confusing passages, pits, potential for flash floods, and the like.

For the permitee, it is the permit that is used to inform them of any potential risks, both general and specific. The BLM Cave Entry Permit (Appendix 5–7) has three basic sections. The first section is the part lists the caves being granted access to and describes the general prohibitions, and requirements and a liability waver. It is also where the visitors sign. Signing the permit indicates that the BLM has advised the caver of specific known dangers, that the caver is aware of these dangers and of the general dangers involved in caving, and that he is knowingly exchanging his right to sue for injury for the right to legally enter the cave. The second part contains the specific Risks and Stipulations sheet (Appendix 5–8) for each cave being permitted. It also has the cave lock combination on it. In this way the visitor is sure to have been given the specific risks and stipulations before they can gain entry. They have been warned. The third part of the permit is a Whit-nose Syndrome (WNS) advisory and decontamination procedures. This notifies the permitee of the threats of WNS to bats and that they are responsible for entering the cave "clean" and conducting the current decontamination procedures before entering other caves.

C. Invitee Category

The third category of persons entering onto the land is considered invitees. Invitees are those who enter with the permission of the owner for purposes beneficial to the owner. A paying tourist in a campground would be an invitee, as would an outfitter/guide or group issued a Special Recreation Permit that they pay a fee for. It is possible that one who enters a cave for the purpose of mapping the cave could be an invitee, if the BLM receives the benefit of the resulting map. The duties that the landowner owes an invitee include the duty to warn of unsafe conditions, the duty to use reasonable care to inspect and discover dangerous conditions, and the duty to take reasonable steps to mitigate the known hazard if practical.

The BLM should never require the caver to demonstrate their ability, as in requiring them to demonstrate their ability to rappel, or place artificial aid. In doing so that is considered as judging their competence to perform the demonstrated activity and is passing judgment upon whether their demonstrated level of skill is sufficient for safe traverse of the cave. Likewise, the BLM should not give a recommendations regarding specific caving gear such as a specific brand or generic type of equipment. This increases liability to the BLM. Conversely, entry should not be permitted to enter a cave with obviously inadequate gear, or with equipment that is clearly worn to the point of unreliability.

IX. GEOCACHING

The BLM believes that geocaching is an appropriate casual use of public land. Geocaching has been addressed in IM 2005–092. A special recreation permit (SRP) is not required if the geocaching activity complies with casual use conditions. Even though geocaching appears to be an acceptable activity on BLM managed land, it is an activity that would only be welcome in the appropriate locations. Caves may not be considered an appropriate place for a geocache considering their locations would be posted as destination points, there may be sensitive resources that could be disturbed by casual use, and there may be safety concerns involved.

If these or other undesirable situations are the case or the site becomes a management issue in a particular area try to locate a person or group that is responsible for the cache and have them remove the cache. If the site is not removed within a reasonable amount of time after notification, then the cache should be removed from the cave. Normally, the

cache could be determined to be abandoned property after 72 hours unless other appropriate authorization has been obtained.

The general website for geocaching is *www.geocaching.com*. When you enter this website you can type in your zip code and see all the cache sites in your area along with the site's latitude, longitude, a narrative description of the site location, the contents of the cache, and sometimes a map. Geocaching is a sport that is undertaken by people traveling across the country and gives them a diversion or primary activity along their way. Families and groups geocache as an outdoor activity. If geocaching is an active interest in your area you can check their web site to see if there are any caches at BLM caves.

X. OUTFITTER/GUIDES - COMMERCIAL USE

It is sometimes difficult to determine how much information and advertisement to put out there about your cave program. On one side, the less visitation and use the less impacts and damage there will be to the caves and their resources. On the other side, the caves should be available for public use. This is where a detailed cave inventory and management plan can provide some direction. Using this information decisions can be made as to which caves, if any, are suitable for various types of touristic or commercial use. The more delicate or sensitive the cave and its resources are the less likely they may be available for commercial use.

Some caves may have permit restrictions such as only two permits issued per month or only one per month. If commercial use begins to impact the issuance of recreational permits a limit or percentage of permits available per year may have to be set for the commercial use.

There are different types of commercial users that may be interested in public land caves. An Outfitter/Guide business may bring with it a different expectation of experience they want to have for their client and therefore may be looking for caves that are more challenging and hold more physically demanding passage. Such encounters as vertical drops, climbing with belayed exposures, long caves that take advanced navigation skills, and caves with a water element that make it more demanding may be more of what an "adventure" based client is looking for.

Another type of commercial use is for educational purposes. The National Outdoor Leadership School (NOLS) is such an organization. Their goal is to begin their students at a very novice level and bring them up to through more and more challenging experiences while teaching them the basics of caving as well as the various elements of the sciences of speleology; geology, biology, hydrology, archaeology, paleontology, etc. Their courses are taught in conjunction with a university where students can receive college credit for their work.

Regardless of what type of commercial user you have they will all have to complete a Special Recreation Application and Permit form (2930–1). Special stipulations that are placed on the permit would include those that are in association with the caves to be visited plus any camping requirements. Additional stipulation could be that all participants are required to use low impact caving techniques such as those described in the **Leave No Trace Caving** and backcountry camping brochures. Additional reminders of packing out **all** waste materials both solid and liquid, staying on trails where they exist, and not disturbing any of the wildlife (bats) are good thing keep out there.

As part of the Special Recreation Permit process an environmental assessment should be written that describes the impacts of cave visitation. The EA can also cover the issuance of recreational caving permits as well. An example of a caving EA is in Appendix 5–28.

XI. BEST MANAGEMENT PRACTICES

This section is designed to provide guidance for specific land use actions that may affect caves or karstlands. Each land use action has language for environmental assessments that can be attached to rights-of-way, applications for permits to drill (APDs), grazing leases, or other actions. There are also stipulations, conditions of approval, and mitigation measures that can be added.

Classifying karst areas as to density of features can help in the decision making process with regard to what stipulations to add and where. General classifications of Low, Medium, High, and Critical make it easy for personnel to know what stipulations to attach and where. The definitions for the Karst Occurrence Zones are as follows:

A. Karst Occurrence Zones

1. **Critical Karst Zone** - Critical karst zones are those areas in known soluble rock types with high density of significant cave systems and/or bedrock fractures that lead to the rapid recharge of karst groundwater aquifers from surface runoff. These areas provide critical drinking water supplies for major communities, ranching operations, and springs that support rivers and vital riparian habitat.

2. **High Karst Occurrence Zone** - High karst occurrence zones are in known soluble rock types and contain a high frequency of significant caves and karst features such as sinkholes, bedrock fractures that provide rapid recharge of karst aquifers, and springs that provide riparian habitat.

3. **Medium Karst Occurrence Zone** - Medium karst occurrence zones are in known soluble rock types but may have a shallow insoluble overburden. These areas may contain isolates karst features such as caves and sinkholes. Groundwater recharge may not be wholly dependent on karst features but the karst features still provide the most rapid aquifer recharge in response to surface runoff.

4. **Low Karst Occurrence Zone** - Low karst occurrence zones may be in areas of insoluble rock types or in areas that have soluble rock types at depth with occasional karst features such as shallow surface depressions with few known caves.

Additionally, the use of a matrix further simplifies the process. (See following table)

B. Cave Karst Conditions of Approval Matrix

Note:

- This matrix is only a guideline. Actual conditions of approval may change as a result of field exams.
- Additional Drilling, Casing, and Cementing procedures may be required depending on location.

CONDITION OF APPROVAL	CRITICAL	HIGH	MEDIUM	LOW
Berming	X	X	X	X
Leak detection System	X	X	X	X
Automatic Shut-off System	X	X	X	X
Closed Mud System w/ Buried Cuttings Pit			X	
Closed Mud System w/ Cuttings Pit; Cuttings Removed			X	
Closed Mud System w/ No Pits; All Fluids and Cuttings Hauled Off	X	X		

CONDITION OF APPROVAL	CRITICAL	HIGH	MEDIUM	LOW
Fluorescein Dye	X	X		
Lost Circulation	X	X	X	
Delayed Blasting	X	X	X	X
No Blasting	X	X		
Abandonment Cementing	X	X	X	X
Pressure Testing	X	X	X	

Critical Karst Areas - Areas that contain high density of significant caves and/or provide important karst groundwater recharge for domestic drinking water supplies and springs.

High Karst Areas - Areas of known karst geology that contain high density of significant caves and karst features.

Medium Potential Karst Areas - Areas of known karst geology that contain dispersed caves and karst features.

Low Potential Karst Areas - Areas of questionable karst geology and few if any known caves or karst features.

A. Linear Rights-of-Way

Affected Environment

1) The proposed project… is located in gypsum karst terrain; a landform that is characterized by underground drainage through solutionally enlarged conduits. Gypsum karst terrain may contain sinkholes, sinking streams, caves, and springs. Sinkholes leading to underground drainages and voids are common. These karst features, as well as occasional fissures and discontinuities in the bedrock, provide the primary sources for rapid recharge of the groundwater aquifers of the region.

1) [OR]

2) The proposed project… is located in a limestone karst terrain—a landform that is characterized by underground drainage through solutionally enlarged conduits. Limestone karst terrain may contain sinkholes, sinking streams, caves, springs and lineaments. These karst features, as well as occasional fissures and discontinuities in the bedrock, provide the primary sources for rapid recharge of the groundwater aquifers of the region. Lineaments, linear or curvilinear surface features that indicate joints or fractures at depth, which have reached the surface, may be present. In the Guadalupe Mountains, these features are often found in association with caves.

The BLM categorizes all areas within the Carlsbad Field Office as having either low, medium, high or critical cave potential based on geology, occurrence of known caves, density of karst features, and potential impacts to fresh water aquifers. This project occurs within a [Critical, High, Medium] karst zone and is located within _____ feet/miles of _____ known cave(s) or karst feature(s). A [Critical, High, Medium] karst zone is defined as an area (Pick the appropriate zone definition and insert the section in quotations here. Delete the other definitions.)

Critical Karst Resource Zone - Karst areas with a high density of significant cave systems and/or bedrock fractures and other karst features that lead to the rapid recharge of karst groundwater aquifers from surface runoff. These areas provide critical drinking water supplies for major communities, ranching operations, and springs that support rivers and vital riparian habitat. These areas include the Capitan Reef and associated

Capitan Aquifer west of the Pecos River as well as the surface outcropping of the Castile gypsum formation in southern Eddy County.

High Karst Potential Occurrence Zone – Areas in known soluble rock types that contain a high frequency of significant caves and karst features such as sinkholes, bedrock fractures that provide rapid recharge of karst aquifers.

Medium Karst Potential Occurrence Zone – Areas in known soluble rock types that exist at surface level or within 300 feet of the surface but may have a shallow insoluble overburden or soils that mask surface features. These areas may contain isolated karst features such as caves and sinkholes. Groundwater recharge may not be wholly dependent on karst features but the karst features still provide the most rapid aquifer recharge in response to surface runoff.

Field notes from the on-site inspection indicate that _____. Unknown features may also exist. Due to these factors, this action is subject to mitigation measures designed to adequately protect known and potential cave/karst resources.

Sinkholes and cave entrances collect water and can accumulate rich organic materials and soils. This, in conjunction with the stable microclimate near cave entrances, support a greater diversity and density of plant life, which provides habitat for a greater diversity and density of wildlife such as raptors, rodents, mammals, and reptiles.

The interior of the caves supports a large variety of troglobitic, or cave environment-dependent species. The troglobitic species have adapted specifically to the cave environment due to constant temperatures, constant high humidity, and total darkness. Some of the caves in the area contain bat colonies. Many of the caves in this area contain fragile cave formations known as speleothems.

1. Impact of Roads to Cave and Karst Resources

A possibility exists for slow subsidence or sudden catastrophic collapse of a sinkhole, cave passage, or void during road construction operations, with associated risks to operators, equipment, and potential for increased negative environmental impact. These subsidence processes can be triggered or enhanced by intense vibrations from construction or rerouting or focusing of surface drainages.

Roads and road drainage turnouts can direct or funnel runoff water into cave entrances or sinkholes. Contaminates from spills and general road runoff (such as oil and other petroleum products, salt water, and other debris) can be transported directly into the cave systems causing negative effects on the cave environment and ecosystem. Because cave ecosystems are extremely fragile and easily disturbed, the negative effects to the cave's biological components may include disruption of some of its species. Because karst terrains and cave systems are directly and integrally linked to groundwater recharge, contaminates spilled on roads in these areas may lead directly to groundwater contamination.

Buildup of toxic or combustible fumes in caves and cave entrances from spills on roadways may harm wildlife and cave visitors and, in extreme cases, lead to asphyxiation or rapid ignition in the rare event that the fumes are ignited by visitors.

Mitigating Measures for Roads

Roads will be routed around sinkholes and other karst features to avoid or lessen the possibility of encountering near surface voids and to minimize changes to runoff or possible leaks and spills from entering karst systems. Turnout ditches and drainage leadoffs will not be constructed in such a manner as to increase or decrease the natural flow of water into or out of cave or karst features. The BLM, Carlsbad Field Office, will be informed immediately if any subsurface drainage channels, cave passages, or voids are penetrated during construction and no further construction will be done until clearance has been issued by the Authorized Officer. Special restoration stipulations or realignment may be required.

All spills or leaks should be reported to the BLM immediately for their immediate and proper treatment.

2. Impact of Power Lines to Cave and Karst Resources

A possibility exists for slow subsidence or sudden collapse of a sinkhole, cave passage, or void during power line construction operations, with associated safety hazards and potential for increased environmental impact. Opening a new entrance into a cave system can change air flow patterns, temperatures, insurgencies, mineral development, and biological community and may cause other undetermined effects on the cave ecosystem. Encountering a void would also have adverse impacts on the stability of the power pole and may result in the subsequent failure of that pole.

Mitigating Measures for Power Lines

Smaller power lines will be routed around sinkholes and other karst features to avoid or lessen the possibility of encountering near surface voids and to minimize changes to runoff or possible leaks and spills from entering karst systems. Larger power lines will adjust their pole spacing to avoid cave and karst features. The BLM, Carlsbad Field Office, will be informed immediately if any subsurface drainage channels, cave passages, or voids are penetrated during construction and no further construction will be done until clearance has been issued by the Authorized Officer. Special restoration stipulations or realignment may be required.

3. Impact of Buried Pipelines and Cables to Cave and Karst Resources

A possibility exists for slow subsidence or sudden collapse of a sinkhole, cave passage, or void during trenching operations, with associated safety hazards to the operator and potential for increased environmental impact. Slow subsidence or sudden collapse of sinkholes may also leave pipelines hanging and increase their possibility of leaking or failure. These subsidence processes can be triggered or enhanced by intense vibrations from construction or rerouting or focusing of surface drainages.

Buildup of toxic or combustible fumes in caves and cave entrances from leaking or ruptured pipelines may harm wildlife and cave visitors and, in extreme cases, lead to asphyxiation or rapid ignition in the rare event that the fumes are ignited by visitors.

Contaminates, such as salt water, oil, or other petroleum products, from spills can be transported directly into cave and karst systems causing a negative effect to the cave environment and ecosystem. Because cave ecosystems are extremely fragile and easily disturbed, the negative effects to the cave's biological components may include disruption of some of its species. Because karst terrains and cave systems are directly and integrally linked to groundwater recharge leaking or ruptured pipelines in karst areas may lead directly to groundwater contamination.

Mitigating Measures for Buried Pipelines, Etc.

To avoid or lessen the potential of subsidence or collapse of karst features, toxic or combustible gas buildup, or other possible impacts to cave and karst resources from buried pipelines or cables, alignments may be rerouted to avoid karst features. The BLM, Carlsbad Field Office, will be informed immediately if any subsurface drainage channels, passages, or voids are intersected by trenching, and no pipe will be laid in the trench at that point until clearance has been issued by the Authorized Officer. Special restoration stipulations or realignment may be required at such intersections, if any. Leak detection systems, back flow eliminators, and differential pressure shut-off valves may be required to minimize the impacts of leaking or ruptured pipelines. To eliminate these extreme possibilities, good record keeping is needed to quickly identify leaks for their immediate and proper treatment.

B. Oil and Gas Drilling and Production

The BLM must balance developing oil and gas resources with the protection of cave and karst lands and the water resources associated with them.

The risks to industry can include excessive loss of drilling fluids, loss of tools and equipment downhole, downtime while fishing for tools, and expense for extensive cementing programs. In extreme instances the

loss of drilling rigs and equipment due to the catastrophic collapse of shallow cave passages add risks to public health and safety.

The potential hazards to cave/karst resources result from contaminants that may enter into the cave/karst systems. These contaminants include such things as lost drilling fluids (which sometimes contain chemicals) and cements, and hydrocarbons from spills or leaks from well casings, storage tanks, mud pits, pipelines, and production facilities. This contamination could result in pollution of groundwater and aquatic and atmospheric habitats of caves, causing a die-off of cave life. Additionally, cementing operations could affect portions of underground drainage systems by restricting groundwater flow and introducing pollutants into karst systems. This could alter the quality and quantity of water reaching springs and resurgences.

Other possible impacts are vented or escaped gases, such as natural gas or hydrogen sulfide, collecting in sinkholes and caves. These gases can cause a die-off of plant and animal life that use the special habitat created by the microclimate of the cave entrances or sinkhole. In the extreme, buildup of these gases has the potential to cause underground explosions and/or asphyxiation of plant, animal, and possibly human life.

In Appendix 5–29 there is an example of an environmental assessment for an oil or gas application for a permit to drill (APD). Certain sections are in red, indicating that when writing the EA the author should choose what description or language best suits their situation then delete the unneeded language.

Appendix 5–30 contains an example of Conditions of Approval for oil or gas wells.

Appendix 5–31 gives an example of specific drilling, casing, and cementing requirements for drilling oil and gas wells in Critical, High, and Medium karst potential zones.

C. Grazing

Cows can make a mess and cause the contamination of springs and associated riparian areas. Below is an example of language that can go into an environmental d can accumulate richer organic materials and soils.

Grazing Permit Renewal Language

1. **Affected Environment: Cave Karst** - The allotment is located in gypsum karst terrain, a landform that is characterized by underground drainage through solutionally enlarged conduits that may contain sinkholes, sinking streams, caves, and springs. Sinkholes leading to underground drainages and voids are common. These karst features, as well as, occasional fissures and discontinuities in the bedrock, provide the primary sources for rapid recharge of regional groundwater aquifers.

   Sinkholes and cave entrances collect water and can accumulate richer organic materials and soils. This, in conjunction with the more stable microclimate near a cave entrance, supports a greater diversity and density of plant life, which provides habitat for a greater diversity and density of wildlife.

   The caves also provide habitat for a number of animal species. Cave entrances support communities of raptors, rodents, mammals, and reptiles, while the interior of the caves may support a large variety of troglobitic, or cave-dependent, species. The troglobitic species have adapted to the cave environment, which has a constant temperature, constant high humidity, and total darkness. Some of the caves in the area contain easily disturbed bat colonies.

   Many of the caves in this area contain fragile and very delicate speleothems such as stalactites, aragonite and gypsum crystals, and speleogens. Cave passages or karst drainage may exist very close to the surface creating the possibility for slow subsidence or sudden collapse.

2. **Environmental Impacts: Cave/Karst** - Cattle grazing in karst areas, particularly near sinking streams or springs, can cause a great increase in the turbidity and type of organic materials carried into a cave system. Large increases in the manure content and other materials entering the cave ecosystem can cause a

deterioration of the water quality by changing the nutrient value and PH of the water thus becoming harmful to the wildlife in the cave. It can also pose a health threat to any human visitors to the cave.

3. **Mitigations** - Range improvements such as fencing-off fragile springs, riparian areas, and recharge zones can help reduce the impacts to these sensitive zones. Drinking troughs and salt licks can be placed away from recharge areas and springs outside the fenced off area.

D. Logging

The following is an excerpt from the US Forest Service Tongass Forest Plan Appendix H January 2008. It is recommended here that the no-harvest or disturbance zone should be up to 300 feet of any aspect of a known cave or karst feature.

No surface-disturbing activity such as timber harvest, road construction, and/or quarry development shall occur within a minimum of 100 feet of the edge of a cave, sinkhole, collapse channel, doline field, or other collapse karst feature. Manage an appropriate distance beyond the no-harvest zone to provide for a reasonable assurance of wind-firmness (RAW) of that zone (pay special attention to the area within two site-potential tree heights of the no harvest zone). The intent of the buffers surrounding karst features is to minimize the amount of woody debris and sediment entering a given karst system and to maintain, to the extent practical, the natural processes and environment surrounding those features. It is not intended that this level of protection would be applied for relatively minor, isolated features (i.e., where explicit or special management measures would not normally be required). Appropriate protection measures for minor features should be designed on a case-by-case basis as field assessed by a karst management specialist. When designing buffers to protect karst systems and their features, the buffer should be designed to be wind-firm. There is no credible standard buffer distance that will provide the assurance required to protect the systems from blow down of the forest within a given buffer. Each buffer must be carefully designed considering wind direction, blow down history, previous adjacent harvest, topography, and stand wind-firmness. Delineated lands surrounding such features and systems must be of sufficient size to ensure protection even if blow down occurs. It is suggested that the specific design of the buffers be an Interdisciplinary Team (IDT) recommendation working with the karst management specialist during the planning process for any given project. Not all features will require the RAW buffer considering the specific characteristics of each.

No surface-disturbing activity such as timber harvest, road construction, and/or quarry development will occur on lands that overlie a known "significant" cave. "Overlie" is defined here as the area between lines projected from the outside walls of the cave passage at a 45-degree angle to the surface. In practice, lands that overlie a significant cave should be classed as high vulnerability even if other characteristics would suggest a lower rating.